International views on post-Kyoto climate policy implementation

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Glossary

AER	General Energy Council (Algemene Energieraad)
ET	Emissions Trading
EU	European Union
CC	Climate Change
CEE	Central and Eastern Europe
CDM	Clean Development Mechanism
CHP	Combined Heat and Power
CO_2-eq.	CO_2 equivalent
COP	Conference of Parties
DC	Developing Country
FCCC	Framework Convention on Climate Change
FM	Flexibility Mechanisms
GHG	Greenhouse Gas
GNP	Gross National Product
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
KM	Kyoto Mechanism
KP	Kyoto Protocol
KPFCCC	Kyoto Protocol to the FCCC
MS	Member States
NGO	Non-governmental; Organisation
PV	Photo-Voltaic
RIVM	National Institute of Public Health and the Environment
R&D	Research and Development
UNFCCC	United Nations Framework Convention on Climate Change
US	United States of America

1. Introduction

The Institute for Environmental Studies (IVM) was requested by the General Energy Council (Algemene Energieraad -AER) to execute a research project on the international views on post-Kyoto climate policy implementation. The research project is to provide a background paper for the AER in its preparation of a post-Kyoto advice to the Ministry of Economic Affairs.

The research project focuses on identifying the international views on post-Kyoto climate policy (after 2010) within the perspective of the coming AER advice. The possibility of developing a no-regrets strategy in relation to climate change policy implementation focussing on the preparations for the period after 2010 and thus the question on what actions have to be taken in the short-term (e.g. 2003) to facilitate long-term (after 2010) climate policy development is analysed. In accordance with the AER starting note "post-Kyoto" (AER, 2001) the 2002-2010 period is considered as a time basis for policy and investment decisions that effect the 2002-2030 period. The coherence between technologies and instruments is addressed. However, the research project will not give a technical blueprint of technologies that should be implemented for the reduction of greenhouse gas emissions. The following research questions are central to the research carried out:

"What is the range of short-term policy options for promoting technological and institutional change at the national level given different scenarios of medium and long-term climate policy? To what extent are the identified policy options dependent on international and/or European policy? Which of these options are robust, feasible and compatible with different scenarios of medium and long-term climate policy?"

The research project used two approaches for presenting an overview of the different views on post-Kyoto climate policy implementation. First, 10 experts with a clear vision on the future, a pronounced opinion and strategic insight were interviewed by telephone. The experts come from the NGO, industry, negotiation and science communities. The experts selected thus covers a selection of the diverse views amongst influential and esteemed experts in the world. Second, the results of the post-Kyoto workshops held before September 2001 were addressed and third the available literature on the research topic was reviewed to fill as much as possible the gaps that remain and providing a perspective to the interviews. The key interview questions are presented in Appendix I. It should be noted that the majority of the interviews were held prior to September 11 2001 and thus do not reflect the impact of the latest events on international co-operation.

The 'ideal-typical' scenarios for the future presented in Table 1 have been used as a basis for the research. These scenarios include 'opposite' assumptions on the future changes in climate and the level of consensus over international co-operation in the world. In the 'climate change high' assumption the actual and perceived changes in climate in the 2002-2010 period will be rapid with high visual damages and scientific and social consensus on a high risks to human and natural systems will be established. In the 'climate change low' assumption climate will change slowly in the 2002-2010 period with little visual damages and scientific and social consensus on a low risks to human and natural systems will be established. In the 'low consensus over co-operation' assumption there

will be no consensus on international climate change policy amongst the Parties of the UNFCCC and the gap between the EU, the US and the rest of the world will widen. In the 'high consensus over co-operation' assumption there will be solidarity amongst all Parties to the UNFCCC and a high level of consensus on international climate policy.

Table 1 Four potential scenarios for the development of the regime.

	Consensus over co-operation High	Consensus over co-operation Low
Climate change (high)	Scenario 1	Scenario 2
Climate change (low)	Scenario 3	Scenario 4

Different policy measures are possible in each scenario. Some of these measures will be taken in any case because of other driving forces in society (autonomous measures spurred on by issue-linkages to e.g. oil crises, local pollution, implementation of other treaties like the Biodiversity convention). Some measures will have to be promoted by the government. It will be analysed whether policy options are robust (i.e. that they are compatible with different policy scenarios) or if they are likely to be autonomous. The possible relationship with the domestic measures and international co-operation will be identified. Finally the stakeholder views on the pace of emission reduction and the associated trends in global average GHG concentration levels will be addressed.

Chapter 2 first describes the past and current international climate change policy negotiations to give a background to the research. Then some issues for the post-Kyoto climate policy future are discussed. Chapter 3 presents transcripts from the interviews with 10 experts on climate change and related issues. Chapter 4 gives a synthesis of the interviews, workshops and literature before the final chapters give summaries in both English and Dutch.

2. Background to the climate change policy implementation process

2.1 Past and current international climate change policy negotiations

Ten years of negotiations on the climate change issue have led to the adoption, ratification and entry into force of the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and of the adoption of the 1997 Kyoto Protocol to the FCCC (KPFCCC). The negotiations at The Hague in November 2000 broke down because there was no consensus on the issues of the modalities of the flexibility mechanisms (the definition of sinks, supplementarity, etc.), compliance, and the funding mechanisms.

A first step towards consensus on relaxed modalities of the flexibility mechanisms was reached in Bonn in July 2001. However, it is still uncertain whether enough nations will ratify the Kyoto Protocol (KP) enabling it to enter into force now the US decided to go in different direction from the rest of the world. The US argues that developing countries are not taking any action and have no obligations. However, China, India and South Africa – the largest of the emitters in the South – are taking action. While President George W. Bush is opposed to ratification and the US senate had declared in 1997 its opposition, the majority is now in the hands of the Democrats and there is increasing public pressure on Bush not to alienate his foreign allies and his domestic public. As the former Chair of the EU negotiations states: 'It is the US that is isolating itself and not the rest of the

The agreement reached in Bonn and the steps already initiated in relation to Joint Implementation (JI), Emission Trading (ET) and the Clean Development Mechanism (CDM) indicate that there is a momentum in society to try and push matters further.

2.2 Beyond Kyoto

Several key questions regarding Kyoto and beyond are being addressed by a number of international workshops being organised this year in amongst others the UK (by the Royal Institute of International Affairs), in Germany (by Hamburg University) and in the Netherlands (by the Institute for Environmental Studies; by the Royal Dutch Academy of Sciences).

One may argue that the possible future of post Kyoto policies (after 2012) depends more on global trends such as population growth, globalisation, liberalisation, the spread of communication technology, etc. In fact there is probably no such thing as a business-as-usual scenario where futures can be based on projections from existing steps. This led the Intergovernmental Panel on Climate Change (IPCC) scenario developers to take a new approach. They developed four possible future scenarios. The first scenario (A1) assumes rapid economic growth, low population growth, rapid growth of modern technologies and convergence in different regions of the world. The second scenario (A2) assumes a heterogeneous world with widely diverging circumstances in different parts of the world. The third scenario (B1) assumes a convergent world but with more emphasis

on services and information and a socially, environmentally and economically equitable and sustainable global society. The fourth scenario (B2) focuses on local and regional solutions, a diversity of technological change, moderate population and moderate economic growth. For each of these possible future worlds, many scenarios about the future were developed. In all scenarios it is possible to reduce greenhouse gas emissions but the impacts on society will be different (IPCC Special Report on Emission Scenarios, 2000).

One can assume that if the Kyoto Protocol enters into force, the next steps will be developing quantitative and qualitative commitments for the second and following commitment periods for different groups of countries. One can also expect that the flexibility mechanisms will be constantly refined and improved to ensure the environmental integrity of the regime. If the Protocol does not enter into force, then it is likely that the annual meetings of the Conference of the Parties (COP) to the Framework Convention on Climate Change (FCCC) will still lead to pressure in relation to national inventories and communications on policy options in relation to mitigation and adaptation. This will inevitably lead to additional pressure on governments to adopt domestic policies and measures. If flexible mechanisms are subsequently considered necessary, it is not inconceivable that governments adopt a modified version of the Kyoto Protocol, which only includes the mechanisms. However the flexibility mechanisms do not work efficiently in the absence of quantitative targets and commitments.

Against this background the following chapters focus on identification of the international views on post-Kyoto climate policy implementation.

3. Interviews

This chapter presents the transcripts of interviews held with 10 international experts on climate change and climate change related issues. The interviews present the views of the experts as they emerged during the interview and, apart from the common starting point of the implementation of the current Kyoto Protocol, there is no particular order of the topics discussed. It should also be stressed that the interviewees were asked to give their personal opinion on the issues raised, and not that of their respective organisations. Before the interviews were held the interviewees were sent a background paper on the research and the interview questions for preparation. The interviews are presented in alphabetical order.

Baumert, Kevin

Research Fellow, World Resources Institute, USA

The future of the current KP depends on the positioning of the US and Japan, but might also be more dependent on Russia than previously thought. If the US stays out then there might be good chances for ratification. Ratification by the end of 2002 is plausible, but only if the US stays out. US domestic actions will also help the international efforts.

International ET with links to domestic programs will emerge amongst KP countries. Eventually, there will also be domestic ET in the US. The prospects are dim for JI, and even more so for CDM. Nevertheless, CDM will be helped by domestic actions in the US, but at the moment there is too much slack and too weak incentives in the current CDM system. The momentum for ET has been building for years and is seen as more interesting for both business and government than taxation. These efforts will also all be linked to energy efficiency and energy sector reform.

The transport sector will be key to achieve GHG emission reductions. The sector is the fastest growing in most countries. New engine technology, including hybrid fuel cells, hydrogen storage and conversion devices will have to be explored. There must also be more investment and attention towards sequestration. Energy efficiency measures and reform of the power sector will also come about. Investments in renewables are both likely and vital. PV and biomass will have to attract public subsidies.

The prospects for nuclear energy are not good. The economy of the technology does not work and requires public subsidies. These subsidies will be hard to get for a technology that does not have public support.

The measures mentioned above are not really dependent on international agreements. Energy efficiency, tax reform and reform of the power sector can be undertaken for non-climate reasons. Policies are more likely to be developed if they have more than one incentive. Specific examples of this are topics on land use change that will also benefit farmers.

Scenario 3 is the most likely, then 4, 1 and 2 for a 10-15 year time horizon. There will not be any catastrophic events that will determine the future of the climate regime. There

is no 'ozone hole for climate change' or any other scientific evidence that would directly spur immediate action. Concern for the climate will increase over the next 10 years. If it would be possible to pick 'medium' climate change this would be most correct. One must not forget that we have the UNFCCC. The momentum must be kept up. The framework we have provides a useful starting point but there are many concerns about co-operation and factors that will influence that. The willingness of countries to pay for mitigation and adaptation is an important factor.

There are definite double benefits and linkages, such as in land use change and forestry. This will assist not only in tropical areas but also in areas of desertification. There is certainly potential for climate protection offsets to be used for biological diversity measures leveraged to make ecosystems healthier. There is a need for environmental criteria in the KP that go beyond simply CC measures.

It is important that the US stay out of the first commitment period, but essential that they get back in for the second and following periods. The US will have to take the lead to achieve inclusion of DCs. There will be a need for a third group of countries, emerging from the existing non-Annex 1 countries. This group will most likely be made up of progressive and forward thinking countries that acknowledge the problems associated with CC, but who does not want to join Annex I. The rights and obligations in Annex I are inappropriate for DCs. One might instead see sectoral commitments and target indexes based on GNP.

The argument of economic growth versus CC measures is an important consideration. If measures are perceived as costly they will never work. We need to be able to conceive CC measures as being good for the economy. Low cost measures must be pursued, but this will include a lot of measures, including a modest cap-and-trade system, technological development programs, renewable energy subsidies, energy efficiency measures, and agricultural policies. We must start modestly and then grow when costs are revised.

Grubb, Prof Michael

Imperial College of Science, Technology and Medicine, UK

It will be hard to backtrack after Bonn. There is 75% chance of EU ratification and 60% chance of full ratification by Johannesburg (2002). EU ratification will lead to Russian, and then Japanese, ratification. The US might try to derail the process. Few issues could upset Marrakech. The current US positioning towards the KP has unified everyone else.

There is a diverse mix of policies and instruments that will be used for the first commitment period. ET will clearly be used, taxation and industrial exemption will be used in some countries. Renewable policies, critique schemes and vehicle standards will also be important measures. The EU is already ahead on renewable energy policies and schemes. There will be an emergence of cleaner technologies in the US and maybe also a cap and trade system. The Japanese situation is difficult. Russia needs to stabilise its political framework to attract foreign investments. The KP will play an important role in Russian energy (and foreign) policies. Not many countries will meet their targets domestically. It can be questioned if they are willing to spend the resources needed to bridge the gap between domestic reductions and reductions achieved abroad.

Nobody knows about the 2nd commitment period. This will depend on the perceived success/failure of the 1st commitment period. There will be a wider group of countries with commitments, possibly divided into blocks. US participation will be bound up to DC participation, and vice versa.

A third criterion for the determination of future scenarios is the US approach to the climate regime. Expects that the US will be forced back into the protocol. Sees the reactions in the US Congress to the Bonn agreement as a precursor to this. US leadership is seen as essential (in the US) and there are a ½dozen bills coming forward. A broader debate on US isolationism is expected. Politically costs are too high if they stay outside, rules will be developed without them, and will move towards trade measurer. Multinational companies will be tired of having to deal with different set of rules and will want credits for their actions also in the US.

In Europe, renewables and natural gas, plus biomass linked to carbon sinks will emerge as energy solutions. There will be talk but no action on the issue of nuclear. This will be similar for sequestration. The issue of nuclear will vary between different DCs. Only a few DCs have the capacity to invest in nuclear, amongst these are China, and maybe South-Korea (if they should indeed be classified as a DC). Bonn has effectively ruled out credits for nuclear, so any new plants will face major difficulties unless some radical new nuclear technology emerges.

In the US clean coal plus disposal and technology lead solutions will prevail.

Energy efficiency measures are already in place in many (if not all) regions and these will be pursued and strengthened.

Transport will not change unless fuel cells are used in a big way. There will be some shift towards high-speed trains, but mostly as a result of congestion and 'need for speed'.

No major technological (or energy) breakthroughs are expected in the near future. A hydrogen economy with a decentralised energy system could emerge. A large growth in the use of biomass is expected.

Added benefits will not only be seen in relation to other environmental problems, but will also be seen through industrial leadership. This hinges on technological processes and their progress. Costs will be short term but their benefits will be long term. Expects forest conservation to be wrapped up in the KP.

High levels of international co-operation are expected, but it is difficult to predict the level of climate change in the future. A reasonable prospect will be doubling of concentrations with a peak in 10-20 years.

If there is no agreement there will be a patchwork of measures, with a more intensified program in the case of an agreement. Action in DCs and Russia depends on international agreements.

Arguments on impact on national economic growth from climate change related measures are not valid. The cost of CC measures will amount to 0.1-0.2% of GNP, maybe higher for some countries. This will be outweighed by more strategic innovation and less use of resources.

Hare, Bill

Climate Policy Director, Greenpeace International

The KP is expected to come into force in 2002/3, although without US participation. Negotiations on the second commitment period, US re-entry and possible DC entry, plus some additional obligations under the KP, will take place sometime after 2004. The ratification process has already started in many countries and the Bonn agreement supplies enough substance for this process to continue and for entry into force to become a reality within a year or so.

All key parties apart from the US will ratify the KP and the next step will follow. A variety of instruments will be used to meet the obligations under the KP. ET on European level and EU programs on enhancement of renewable energies, including energy efficiency standards and domestic programs on renewables will emerge. Energy taxation at EU level is also an option that will possibly emerge, and changes at the transport level within EU should be expected.

Outside the EU, New Zealand will deal with their need to improve the energy efficiency of their economy and no further fossil options will be explored. No significant action is expected from Australia. Japan will actively use the KMs and introduce top-down rules for energy efficiency. Nothing is expected from Canada.

Nuclear as an instrument to combat CC is a dead issue, although some countries (Japan mentioned) will push for increased use of nuclear energy. Public opinion dictates that no further nuclear plants will be built, especially as they will remain excluded from JI and CDM. There might be discussions on the use of nuclear in several countries, UK, Sweden, Germany mentioned, and although there is strong opposition to the use of nuclear energy, the existing installations will not be replaced in the immediate future.

Massive innovations on energy solutions are expected within the next 50 years, but it is hard to predict which way the energy systems will develop. Fuel cell technologies are already being introduced and will be used at household levels shortly in Germany. A hydrogen society is most definitely an option, and there are several routes to reach the potential for hydrogen. The only question is how. Biomass fuels have a large technical potential for use in the future. There are some technical limitations that will have to be overcome, but biomass energy is currently an underused option that will be given more focus in the future. Photovoltaic will play an increasingly important role, especially given the latest developments on (self)(re)generating organic photovoltaic cells. Large-scale wind energy installations will also play an increasingly important role, but it is difficult to predict the final scale of the technology, as indeed it is with all the above-mentioned technologies.

The big discussion in the future will be the choice of the new energy carrier, and then especially what type of energy that will be utilised for transport purposes.

CO_2 extraction technologies are subject to substantial research, especially in the US, and there use might turn out important in the future. CO_2 storage is increasingly controversial and will meet strong opposition from Greenpeace and other NGOs, whereas geological disposal is seen as 'more OK'.

There are substantial added benefits of climate change measures, especially for land use and forestry.

High levels of climate change are expected, which will result in increased international co-operation. Arguments from industry in such a scenario would probably be that it is too late to do anything about the problem and that efforts should be shifted towards adaptation and a gradual transition towards a 550-560 ppmv concentration. This attitude would of course change in the aftermath of direct climate catastrophes in rich countries.

The concept of no-regret options is not valid. Admittedly energy efficiency and R&D can be seen as such, but the lack of action on these policies in the past shows a different view. If these options really were seen as no-regret options they would have been implemented to a much higher degree already. No-regret policies are identified but politicians cut back on funding and implementation of these options often meet with opposition when initiated. No-regret options constitute an 'intellectual smoke screen' and do not amount to anything substantial.

Regardless of international co-operation there will be continuation of some programs and technology solutions. This progress will come about for different reasons, but most countries will not go ahead with their programs. The UK, Sweden, Germany and maybe the Netherlands are countries that are seen as progressive enough to continue their work regardless of international agreements. Nothing can be guaranteed at EU level. In the absence of an international agreement the leaders, Germany mentioned, will probably lose their interest and their leadership position might collapse.

If there is a high level of economic growth then it will be easier to renew infrastructure, there will be larger replacement of capital, and the system might be self-regenerating. For DCs there might be a different dynamic, and failure of (energy and non-energy) technology solutions to repay their investments will result in a lock-in on fossil technologies.

There will be binding emission limitations for groups of DCs. The differentiation between the DCs could not be done solely on per capita or GNP comparisons, but GNP per capita might be one of the parameters that will be used to set an important threshold for commitments to be undertaken, but the process will be more difficult and fuzzy than just that. There might be a revisit to the dropped Annex C with energy efficiency for finance.

China and India are a long way from accepting any commitments, whereas Latin American countries might see the advantages of taking on commitments, especially given a favourable trading system. Some countries in Southeast Asia might follow swiftly.

DC participation will of course be dependent on the perception and reality of US participation. The KP must be in force, with some level of US participation, to ensure DC participation.

The commitments for the developed world will have to be substantially improved (i.e. larger reductions) for the second and later commitment periods.

Junfeng, Li

Director, Energy Research Institute, China

There are good chances for the Kyoto Protocol (KP). The protocol is well liked and there is enough will to achieve reductions even without the USA and Japan. It is very unclear when entry into force will take place. EU and other countries, including developing nations, will pull forward to make the KP become a reality in the near future.

Policy instruments such as CDM will give financial incentives for both the developed world and DCs. Business and industry must also be involved to make the system function well. JI is a good idea but CDM will prove more important.

The criteria suggested for the determination of future scenarios are good. Other criteria that could be included are how the protocol/programs is promoted and how easy it is to understand (transparency).

International co-operation must be given incentives through identification of the most important priorities. CDM and business based co-operation needs knowledge to indicate where and how to move forward. The win-win situations need to be clearly identified and presented.

Energy solutions are important, especially energy efficiency measures and renewable energy. These options are no-regret options and will also have added benefits. The use of these energy measures will open up a lot of business, and it is important to have clear targets for the use of these measures, but these do not necessarily have to be climate related.

Nuclear energy is a very powerful technology (yields large amounts of electricity) and will be important in the short term (up to 2050) until renewable energy has been developed and commercialised. There will be a significant role for renewable energy in the long term but it needs substantial R&D.

Added benefits: solar and wind energy will directly benefit poverty alleviation as these energy sources can supply energy to areas where there is no infrastructure for larger energy options. These benefits will mainly be local and will also include environmental benefits.

It will be difficult to establish the magnitude of CC in the short term, as this evidence will need to be collected over a longer term. International co-operation will of course depend on the significance of CC but it is difficult to establish now how this will be viewed in the future.

Domestic energy efficiency policies and actions, including the use of renewable energy sources and also some nuclear will take place regardless of the level of co-operation. If there is international agreement and a high level of co-operation then these measures will be introduced much faster. The use of renewable energy will be given incentives through international co-operation and financial and economic support. China and India will emerge as hot spots for the use of renewable energy.

The link between economic growth and climate related measures needs more research. It will be very difficult to establish where the optimal point of policy implementation is (the point where measures do not compromise economic growth).

Second and later commitment periods: the most important question for DCs is what the developed world is doing, and then especially the EU and US. To wait for DCs to take commitments would be a waste of time. Financial and development support will be important commitments to undertake for the developed nations. Technology transfer and financial support will be increasingly important, especially under CDM, and it is important to have a money flow from the developed world to the lesser-developed world.

Kimura, Kotara

Director, Global Industrial and Social Progress Research Institute, Japan

Parties can reach enough agreement to start their ratification process at COP7. However, it may take longer time than expected to conclude necessary policies within each government that enables ratification. Russia will finally ratify KP, but it might take slow start. In addition, US approach to climate change is still uncertain. Since US is in a very comfortable position from industries' competitiveness viewpoint, this aspect may have some influence over each government decision. Taking these factors into account, early entry into force of KP, at least in 2002 seems unrealistic, even if it becomes effective.

What approach US will take on climate change is a key to the fate of KP. US involvement is indispensable from both environmental and economic perspectives. Without meaningful US participation, developing countries' involvement can never be expected. We have to make all efforts in order to bring US back into the process. Although there is a new movement including both Republicans and Democrats within US Congress, US new approach remains to be seen. Therefore, it is too premature to make any prediction on the future of KP, not to speak of 2nd commitment period and beyond.

Concerning nuclear energy, one thing must be clarified: Japan relies on imports for about 80% of its energy consumption. 80% excludes nuclear energy. The dependency will rise to over 90% without it. Unlike Europe and US, grids and pipelines are not connected with foreign countries. Therefore, nuclear energy is very important both to combat climate change and secure energy supply. In formulating policies, each country's circumstances must be respected. Nuclear energy will play a meaningful role at least until middle of this century.

Under any scenario, technology transfers to developing countries and R&D on innovative technologies are best no-regret policies. Environment friendly and efficient technologies should be transferred to developing countries through as many channels as possible, including CDM, if KP becomes effective. Concerning innovative technologies, both technologies to reduce CO_2 emission and sequester CO_2 are to be pursued. Recently, advisory body to Minister for Economy, Trade and Industry issued a short report that deals with these technologies. International collaboration is strongly recommended.

The future of the climate regime is dependent upon the US approach to the problem. If the US is out of the solution then it will be nonsense to continue the protocol, both for environmental and economic reasons.

In the future there will be commitments made by the developing countries although these will take a different form than for Annex I countries. A gross target for the developing countries is expected. The Annex I targets will also be renegotiated, with lower targets

for Japan, where a per capita approach might be considered a useful tool. In general, it is hard to establish what these new targets will be or how they will be negotiated.

Minett, Dr Simon

Cogen Europe

The Bonn agreement is good and the process should start now. The Americans will come on board eventually. The agreement is weaker than the original. The EU is expected to ratify in 2002 with other countries following swiftly. Entry into force is expected from 2003. Carbon prices will be low in the early phases, which will only stimulate cheaper options.

As for future agreements things will get a lot tighter. The reduction targets we have now are totally inadequate. To meet a situation where anthropogenic impacts on the climate are sustainable we need a reduction in the order of –15% to –80%. There will be a definite deepening of the targets over the next 10 years. A better scientific understanding of the problem will result in higher levels of international co-operation. The future will show that the costs associated with the reductions are not as high as some forecast. The experiences from the BP and Shell internal ET schemes can be used to prove this point.

With the renewable and cogeneration targets and directives and other already initiated programs EU will meet the targets for the first commitment period. There are, however, questions about the political will that need to be answered.

DC targets must come but the US approach to this situation is much too arrogant and almost colonial in its nature. By the 2nd commitment period the DCs will have to come aboard. Differentiation of the DCs is inevitable.

The level of CC in the future is difficult to establish at the moment. Single events might be more important than long-term trends for establishing political will. Consensus on the scientific understanding of the problems will trigger higher levels of international co-operation and this will again lead to an understanding of higher levels of CC. The IPCC is doing an enormous amount of good work on this issue.

The recently finalised EU CC program with multi-stakeholder consultation gives good indications on where the EU will focus their efforts in the future. ET in EU and a whole raft of other policies and measures will emerge. These are being ranked according to cost effectiveness criteria. There is an enormous scope for doing things at low costs. For instance, CHP costs a lot of money, but the level of taxation or other economic instruments do not need to meet the costs as carbon costs of € 3-4 per ton will trigger the introduction of CHP, even though this is a process that will most often be introduced anyway. Energy efficiency can be improved by 20-40%, cogeneration can account for 20-30% of all energy usage, and renewables 20%. These measures will have various degrees of cost-effectiveness but will be more cost-effective than other options like nuclear and carbon sequestration, which have hidden costs disguised as subsidies. This means that we can cut 20% of 65% of the total emissions without compromising cost effectiveness. In that respect the timetable for implementation of these measures is more important. There is a large volume of investments needed to meet these targets, and the longer we wait the harder it will be to reach them. Capacity- and personnel limitations are major obstacles.

Some might consider nuclear energy as an option, but the use of nuclear energy is not valid for several reasons. This can be seen from both a cost effectiveness viewpoint with hidden costs disguised as subsidies, and from the understanding that nuclear energy is 'emotionally not wanted'. Will nuclear be accepted if we experience high levels of CC? No. The technology will not be accepted either in the EU nor the US. Nuclear is an engineering solution that does not fit the model of the world. If nuclear emerges as a solution in DCs there will be a whole new array of problems that will have to be dealt with.

As for technological innovations in the future the Cool Europe project has identified two paths: biomass dominated energy supply (35% of total supply), and wind and solar energy based supply. In the latter there will be a need for an energy carrier for the surplus. This might be hydrogen based but there are several constraints on hydrogen technology, such as societal and technical constraints, as well as significant on-costs for transformation. This transformation might be easier in the transport sector.

Fossil fuel refining (stripping) and disposal is just a technical quick fix.

It will be important to introduce proper standards on energy use, as we already see in the energy sector. A phasing out of power generation could be used to achieve this. The setting of energy standards on appliances and cars could also be transferred to power stations. The standards could be put as carbon efficiency, age, or efficiency. By tightening the targets over time there would be a gradual phasing out of the most polluting stations and processes. This will open space for renewables and cogeneration. This measure should also be introduced for cars and appliances on a larger (EU) scale.

Notes that the Commission is willing to go down this (and other) routes, but that Member States (MS) are more sceptical. With increased levels of CC we will see more MS participation, and we might have a shift from the traditional north-south EU divide into an east-west divide. Then again, the CEE countries might surprise us all.

The implementation of CC measures will not compromise economic growth. On the contrary, a move towards more sustainable technologies will stimulate technological development and create a whole new market that will contribute to the economy. Cogeneneration, renewables and energy efficiency measures are all good for the economy, whereas end-of-pipe solutions are purely costs. Climate related measures might affect the economy when we go deeper (larger reduction targets) but new economies might emerge. The US approach, that CC related measures might destroy the economy, is not a valid argument.

As for policy instruments or approaches it is recommended that MSs should come up with targets (either carbon or efficiency targets) that should be set through environmental policies (as energy policies will not allow for these changes under the Treaty). These targets will have to be set in a way such that governments will have to meet at least two targets within their term of office. This way we avoid the guilt being placed on previous administrations, the reluctance of passing legislation, and other person problems. Governments are not good at long term planning. Perhaps the way to avoid this is to use international treaties. Targets should be set also under these treaties (although not for the first commitment period of the KP). Targets should be annual or biannual, ensuring two milestones per parliament/term of office.

The Commission has to be more creative. Does not see changes in Treaty to include an energy chapter. There are upsides and downsides to this. We might see a change in attitude over time, with increased co-operation between the Commission and the Parliament.

CC measures will be taken as a result of a mix of incentives.

Gas fired co-generation is an interim step towards a renewable future which will also include energy efficiency and cogeneration for renewables. It is difficult to see a zero fossil economy emerging within the next 50-100 years.

Moorcroft, Dave

World Business Council for Sustainable Development

The greatest importance of the current KP is as a catalyst rather than as an instrument. The way things have gone points to ratification by some countries but not entry into force. Implementation without ratification is also a possible outcome. The main problem of the current KP is that it sits within an expert arena; the general public and consumers at large are not informed about the issues.

Ratification can be expected by a number of countries, at the World Summit at the earliest, followed by implementation measures to inform consumers. This will produce tangible outputs. A lot will also depend on how multilateral co-operation develops in light of the recent world events. The importance of multilateral co-operation is emerging, and the USA may place more importance on multi-lateral agendas. There will be a positive move towards a broader socio-economic agenda. The world and the political economy have changed, although the impact of changes on the climate change debate will take place at an uncertain pace and scale.

The future of the climate protocols, the second and coming commitment periods, depends on what happens in the next 2-3 years. There is a clear issue to deal with: establishing viable real long-term goals. We must deal with a number of uncertain and ambiguous issues on a larger and longer scale. There must be a whole range of capacities for nations to meet their goals within this context. The KP is an important vehicle to build consumer awareness and in the short term it is important to see a price of carbon emerging. This will contribute greatly to an increased attention and inquiry into climate and energy issues by consumers at large.

Without exception the biggest criticism from DCs is that the current KP is an exclusive device aimed at industrialised countries. Recognition of developing country performance is a big missing factor, and the focus on developed country targets is partly a cause of that. The issue with targets is how they are managed, and the transparency of how targets are established; the fact is that current targets are more the result of negotiation skills than fundamental issues. There must be more focus on recognition and results. Instead of having black and white targets there need to be more transparency. We should not worry too much about academic generated dilemmas, but instead look at long-term goals and aspirations. We must also tackle a conflict of values via a longer-term horizon. There are a lot of divides, both North-South and transatlantic. There must be realisation that what works in one place does not necessarily work in another.

The climate regime will have to include an increasing awareness of the broader socio-economic agenda, which will be a fundamental driver in the future. Aspects that will be considered in the future includes resource use, population growth, wealth creation in DCs, are all examples of issues that are growing in prominence.

Energy will increasingly come into focus for the next decade. This will also include issues of diversification, access to markets, security of supplies, etc. These issues could be pushed into the right direction by the CC agenda. The diversification and range of technologies could gain greater importance. This could be of special importance to China and India.

There are clear benefits from climate related measures within a more integrated approach, which will have a broader impact on a broader set of issues. The set of policies and instruments that we have at the moment are not integrated enough. We must strive to find complimentary solutions. One of the real barriers that must be overcome is the conflict of policies. Issues like water management, biodiversity, a whole range of development issues, trade, security, and regional issues will all have to be considered in relation to climate measures.

CC itself is not the best locus for driving policies. The development agenda will be predominant. If CC policies are seen to block immediate human needs then it will be increasingly difficult to introduce CC measures. If the current and future KPs are to succeed there must be an inclusion of development issues, and the protocol must be 'taken

ve paradigm of the developed countries.

The drive towards a hydrogen society is emerging. A critical path will be the interim measures, including transformation of the distribution systems. The transport sector will be crucial, and interim measures with transport and vehicles will be very important drivers. This will include more efficient vehicles, hybrids, and fuel cells on a commercial scale. These interim measures will lead to an infrastructure for a hydrogen-based economy.

The key issue with renewable energy will be to make these technologies significant in the developed world. One must look at how to deploy such technologies in developed countries in order to achieve the scale and critical mass to support cost effective deployment in the developing world. Potential drivers for this will be energy supply issues including diversification and security of supplies. The KP can be a catalyst for getting these things off the ground and we must allow people and markets to experiment with a variety of policy measures and instruments. To achieve this it is crucial that a price of carbon is established.

The life-cycle analysis of nuclear energy is well known and the technology is not viable on economic grounds alone. The choice of whether or not to use nuclear energy will be secondary to CC and will be chosen for other reasons. Nuclear energy is essentially a red herring in the current CC debate. If there is initial success in deploying renewables, the lower risks and lower capital costs will push nuclear to the background in the climate change debate. The cost and nature of the technology does not lend itself to a development agenda in poorer economies with limited infrastructure and institutional capacity.

In the short to medium term it is essential that there is a whole spread of energy technologies present. The diversity of energy supply is important. If there is political will then governments could drive this agenda forward and stimulate markets.

Scenario 2 is an insightful future scenario; high levels of impact from climate change with low levels of consensus on co-operation. This relationship depends on the extent that the public perceives a connection between weather events and climate change. This could be volatile, since equally the public might conclude that CC is not important if there are a few years of 'good' weather. This leads back to the point made previously that CC is more robustly addressed if it is fundamentally linked to a dimension of socio-economic development, food, water, health, security, etc.

Emissions trading will be very important in developing and understanding of 'carbon' as a valued commodity and getting society to put a price on emissions. There are very low risks involved with these measures but very high upside potentials.

Joint Implementation is trading in all but name. There is a danger of dressing JI up too much. JI will be important for dealing with issues of hot air and transferring assigned amounts money in transparent ways.

The Clean Development Mechanism is an 'offshore' supply of credits outside Annex I that has clear traction with the development agenda. The volume of credits will not be crucial in relation to CC, but will act as a good medium for aligning agendas and as a long-term capacity builder. There is real potential for CDM, but it will not generate significant credits in the first commitment period.

Sinks will play whatever role we give them. Geological sinks may be cost-effective in limited applications depending on the price of carbon, either in connection with existing oil and gas infrastructures through re-injection, or through finding suitable reservoirs. With biological sinks we need to learn by doing, and to use these in a measured way. The issue of biological sinks must be seen through a holistic approach to the biosphere and development. The issue must be managed well and we can then see where it takes us. There are clear natural constraints on sinks that will also have to be taken into account.

The impact of climate related measures on the economy go back to our measures of economic growth. The current measures of economic growth do not encompass criteria of sustainability and are not proper indicators of performance in this area. If we measure the impact of climate measures by neo-classical economics we can expect to see negative impacts. On the other hand, if it were measured in broader terms of performance, one would expect to see beneficial growth and positive impacts. Climate related measures would contribute to economic growth and development and act as a stimulus to innovation. Costs, benefits and damages must be better quantified.

When it comes to the pace of greenhouse gas emission reduction it will be a shot in the dark. There is a landscape of possibilities. By the end of the first commitment period we will probably meet 60% of the target. If we focus on the game rather than the scoreboard we could do better than the target. But this optimism falls off the closer to the commitment period becomes and the longer the negotiations get bogged down in too much detail and bureaucracy.

It is important that a number of countries start moving forwards. Peer comparison will be a great driver for CC actions and performance.

Pachauri, Dr RK

Director, Tata Energy Research Institute, India

Vice Chair, IPCC

The agreement reached in Bonn will lead to a watered down version of the KP. There are several questions that need to be clarified at COP7. Need to find a least common factor for all countries. Sinks and caps and other issues will be key issues for the coming negotiations. The actual reductions that will be achieved through the watered down agreement will be in the region of 1% to 1.5% (from 1990 levels). The general agreement reached at Bonn and the continued work at COP7 will speed up the ratification process and entry into force might happen sometime in 2002. US participation is not expected in the near future.

The 2nd and the further commitment periods are difficult to predict. This will be highly dependent on the position of civil society, and then especially in the US. If the people perceive the CC regime as a part of international government that the US should participate in, then there could be sufficient pressure on the government to join. The question of DC participation is difficult. There will be some kind of commitment, but no commitments will be made on reductions. Commitments could be made on more carbon efficient development; de-linking carbon from the economic growth, but no physical reductions would be accepted. As for the developed nations their commitments would have to be substantially more ambitious. Europe, and also possibly Japan, will take the lead.

A high level of CC impacts is expected in the future. This will come about from the fact that nothing is done (reduction wise) to deal with the problem now. This is also pointed out in the findings of the third assessment report of the IPCC. The level of international co-operation will be low in the near future. It takes 3-4 years for the international community to absorb the assessment reports and a speeded up process cannot be expected until 2015.

The future will see a more efficient use of energy. Especially the transport sector is key here. Pricing and taxation of energy will also be used in developed nations to deal with these issues. Europe and Japan are much more forward looking than the US on these issues. A shift in the energy consumption and production patterns is expected, but not through any major technological breakthrough. The future of fuel cells remains to be seen, this also goes for the future use of renewables. Fuel cells, PV, more efficient biomass systems, and small gas fired turbines will take up a niche market. The future will essentially be based on cleaner and more efficient technologies.

Nuclear energy might receive a boost on parts of the world (US and Japan) in the future but will not be a favoured option in Europe and will not take up a large part in the worlds energy market.

As for further measures and instruments the KMs will not play a major role in the near future and the scale that these mechanisms might have is doubtful. A key issue will be to

see how the money-flow from the north to the south will develop. The functioning of the new funds that are being introduced is questionable.

No regret policies are abundant in existence. If people's values and mindsets can be changed, then a lot more no regret options can be implemented. This must start in a big way in the US and Canada. A number of no regret options exist for Japan, and they are moving forward with energy efficiency. A lot is also happening is developing countries, but mainly for local reasons as opposed to global. There are also a number of no regret policies in Europe. States that people must be told about the no regret options, and they must believe in them, and this can best be done through a change of societal mindsets.

The links between CC measures and added benefits and the KP and other protocols is still unclear. For the linkage of the protocols more co-ordination is important. A focused and efficient use of resources for implementation is necessary. Several areas of overlap can be identified: the Montreal Protocol, Certification, Biodiversity, and Forestry. There is an overlap in most agreements but there is absolute need for a system to deal with these overlaps.

There is no conflict at all of climate-related measures and domestic economic growth. Local benefits need to be adequately quantified. In the end there will be no negative impact on economic growth as a result of CC measures.

Verbruggen, Prof dr. Harmen

Director, Institute for Environmental Studies (IVM)

The current KP is not a well-defined international environmental agreement and will be very difficult to implement. The major problem with the KP is that the instruments with which the countries have to realise their emission reductions are not well defined. This includes the flexibility mechanisms, the EU bubble (which can also be seen as a flexibility mechanism), and the inclusion of sinks.

It was a big mistake to first agree on the targets for GHG emission reductions and then to open the negotiation on the mechanisms. If you first define the reduction targets then conflicts of interests will affect the negotiations on the working of the mechanisms. The protocol should have been developed the other way around; first to get the mechanisms working, including implementation, monitoring and sanctions, and then to agree on targets. The political momentum has been to go for emission reduction targets and then to try to get their way out via the mechanisms. This is a very serious problem.

The role of the different country groups is very complex. The role of the EU has not been very good. Countries like the USA and Japan agreed on targets whereas the EU created the bubble and then allocated their emissions reductions amongst the Member States. This acts as a kind of pre-emissions trading system and is a big frustration for other negotiation parties.

If possible the negotiations should start all over again, or at least further elaborate on the functioning of the KP as it is at present. It is not advised to stop the process or not to ratify the KP. Ratification should be followed by more emphasis on a well-designed system of mechanisms, monitoring and enforcement. Emission reductions could be postponed

for 2-4 years. Sinks should be skipped, as they are not credible. The reduction targets could also be renegotiated, as they are not credible at all at the moment. The main focus must be on credible instruments. The current KP is a bad start to a long process.

There will be no ratification yet, as there is no proper agreement on Bonn. The Bonn agreement is vague and needs to take the form of a written agreement before the Bonn process is ended. National parliaments are not happy about the position of Canada and Japan or the new instruments that are designed for these countries.

The likelihood of scenarios for the KP will be option d) and to a lesser extent option b).

The GATT can be taken as an example for the future of the KP. The discussion of free trade started before the 2nd World War and the treaty to establish a world trade organisation was came about in 1947. The USA was not in favour of the treaty and congress opposed it. The treaty then took the form of simply asking countries to be party to the agreement, and 13 countries (12 after Czechoslovakia left soon after) agreed to this. At the time they only agreed on the rule of the game, then came a round on tariff and non-tariff barriers. It took 50-60 years to reach the targets of the treaty. The lesson is that one must start with the forerunners and not include the back loggers.

The last 5 years are basically lost on climate change. One should more or less start over again. This should not be called renegotiations but further elaboration. International collaboration on other issues might also be important for the KP. The current state of international politics, and possible future scenarios, will affect international strategic objectives, and also international environmental agreements.

DCs should be taken seriously and included in the KP as soon as possible. They must be given something to join, but not only money and projects. DCs are sceptical towards CDM and are concerned about selling their cheapest options first. A system must be developed where it is attractive for DCs to participate. This might take the form of tradable permits or funds or others. It is a pre-condition to the KP that DCs join, and also that they are given clear targets. There must be participation by both developed and developing nations.

The present KP targets are very modest because we didn't define the mechanisms first. If we could agree on the mechanisms before agreeing on targets then –10% to -15% could be feasible by 2010, followed by a doubling every 10 years. This means that a 50% reduction by 2050 would be feasible. A precondition for this rate of reduction is that the mechanisms are properly defined and that there is a well functioning incentive system.

We will see serious signs of climate change in the next 10 to 20 years. International co-operation will be strengthened after 5 to 10 years as a result of these signs. It will take 5 years to clean up the mess from the current KP.

By 2050 we will have a well-functioning incentive system, properly defined mechanisms, structures that resemble a quasi/pseudo market for GHGs, a partly operating ET which can be defined as a JI system, tradable permits or other systems with other names.

The future will use a mix of different energy and technology solutions. Nuclear energy might re-emerge as a relevant option given its carbon free nature and the amount of R&D going into the technology at the moment. We might see smaller and safe nuclear plants, using other nuclear substances as their raw materials. The waste problem must be

solved but 40 years of technological development might solve this. This is not based on scientific data but pure intuition.

Solar PV will emerge as a real option in the long term. The technology has a clear trajectory, but it will take time.

Biomass and wind energy will not be used to a great extent as these technologies take up too much space. It will be impossible to provide the Netherlands energy needs solely through wind energy, as there is not enough space.

Wind energy and reforestation might be used to a limited extent.

Hydrogen technology is an option but it is difficult to quantify the chances for success of this technology. The operation of the technology is difficult. Can be seen as the least likely option.

Underground storage is more likely for the next decades.

A new energy technology might emerge in the next 50 years, but a transition to this new technology is likely to take 100-200 years. Engineers are far too optimistic about the speed of technology transition.

The transport sector will change for 2 reasons, climate change and congestion. No changes will be seen yet. There is no progress in the field. Energy efficiency has been improved, but translated onto new surfaces of car technology (safety, comfort, speed) and not into lower levels of gasoline use. Fuel-efficient cars have been around for a long time, but vested interests prohibit the diffusion of these vehicles. It is very difficult to deal with car producers and they also have a very extensive lobby group. Also, the present day consumers like to have the fast, heavy and comfortable cars. Politicians are afraid to deal with this, partly because of the short-term nature of politics.

There are substantial added benefits of introducing climate related policy measures. Reforestation will improve biodiversity, transport measures and air quality management will improve local air quality, and new forms of transport will lead to fewer accidents and less congestion. The overall quality of life will be improved. Extensive use of biomass might have negative effects on biodiversity, as the solution goes for monoculture. These added benefits would have clear overlaps with agreements on acidification, the health directives of the EU, and biodiversity protocols.

The implementation of climate related policy measures would have no real impact on economic growth. In the long term it is impossible to use this argument. All models looking at the long-term aspects of this come up with negligible results. We have losers and we have winners. Those who have to change their ways are the losers, those who provide the new technologies or solutions are the winners. Hundreds of models on the effects of climate measures on economic growth all come up with the same answer: -0% or +0% impact. If you have more losers than winners you will have a negative impact on the economy, but this will only be sectoral. Companies in the affected sectors will either have to come up with technological solutions or diversify to other activities.

There are a number of potential winners, which will all create new employment and new technologies. Any predictions of negative impacts on the economy are based on sectoral analyses, economic non-credible threats, or their own vented interests.

Zylicz, Prof dr.hab Thomas

Warsaw University, Department of Economics

The American position makes it difficult to go ahead despite the compromise reached in Bonn. The EU and other countries (ex. Poland) will adopt some measures, but they will not be very aggressive. The Protocol will not come into force in the foreseeable future. Equally, ET will not come into force, although there might be some ET aspects under JI projects. Given the right incentives, Poland could generate 20-30 million tonnes for trading, but these incentives are not present. Domestically they can justify negative costs, zero costs, and costs up to USD 5 per tonne reduced.

JI is a matter of inertia and political activity; so much has already been done that some projects will undoubtedly go ahead. These will most likely be bilateral projects and there will be no incentive for wider projects.

Some countries will ratify the Protocol but too few for it to come into force. Russia and Ukraine surpluses may be activated if Russia is stimulated. If there is no ratification it is unlikely that Russia will go ahead on CC measures unless an attractive proposal by the EU is presented. Russia will not be (and was not) attracted by an US proposal (which did/will include formal ET and a formal framework). A EU proposal is expected to be less formal and combine both JI and ET.

The suggested criteria for determination of future scenarios are sufficient and no suggestions for further criteria are presented.

Scenario 4 (low levels of CC and low levels of international co-operation) is the most likely. There will be no formal ET, maybe some form of surrogate ET through soft and discretionary JI and CDM, but it will not be considered effective. There will be no full-fledged market for emissions.

Political development will result in JI and CDM based on trade (and tax-) incentives from national governments, which will stimulate domestic companies to take action abroad. These projects will be of limited scale and their cost effectiveness will be compromised. EU countries will continue JI and tax allowance for those who obtain emission reductions elsewhere (ex. Netherlands, Germany).

In the case of Poland there is a large over-supply of installed power and there will be no new power plants built in the next 5-10 years. The only new plants will be renewable plants, which will be installed mainly for decoration purposes, and to meet the government's commitment to increase the share of renewable energy from less than 1% to 7-8% within 10 years. This commitment will be fulfilled through wind energy, hydroelectricity, biomass plants, etc. There will be some decrease in CO_2 as a result but these reductions will not be driven by cost effectiveness (politically driven). There will be no new nuclear plants built in Poland or the rest of Central and Eastern Europe (CEE).

As soon as the EU market is liberalised there will be more energy available in Poland (and in CEE). This raises the problem of Poland's large trade deficit, which will affect the currency rate and overturn the tendency to buy energy from the EU. The EU surplus of energy will therefore not be so interesting.

With the EU energy market liberalised and the accession towards the east there will be a real incentive for energy producers to change their peak hours, something that will give some CO_2 reductions.

EU nuclear energy will be used as much as possible and sold to the CEE, depending on the exchange rate but no new nuclear plants will be built.

No new groundbreaking technologies are expected up to 2020. There will be a growing supply of renewables. Does not wish to speculate any further.

There will of course be both double and triple benefits from CC related measures. Therefore, Poland and other countries might go after CO_2 reduction programmes because of their local advantages. At the moment deforestation is no problem in Poland and reforestation can (and will) be achieved through domestic policy. If credits were to be given for reforestation then Poland (and other countries) would have added incentives to go ahead with these projects. These projects are currently not driven by Kyoto but by other driving forces (local advantages, domestic political activity, etc.).

There will be no aggressive CC related policies, but traditional environmental policies with added benefits. Most importantly will be the use of energy efficiency measures such as thermo-modernisation of buildings, and replacement of existing low stack burners with gas-fired burners with higher stacks.

Using Poland as example: If there was an incentive to reduce CO_2 at a selling price of 15-20 USD per tonne, then financial profits would be the driving force for carbon reducing projects. There would also probably be a more substantial shift from coal to gas (low stack emissions). A total switch from coal to gas has the potential to reduce 10 mill tonnes of 110 mill tonnes total emitted, most of this in 'good' burners. However, there is no domestic incentive to undertake a total switch, and this will require international government to provide incentives.

There is a barrier between energy efficiency and economic growth rate but will not put any number on how much energy efficiency is justifiable. CC policies must not be too aggressive.

If there were potential for ET then Poland would take some commitments. If not, then as little as possible would be done as slowly as possible. Poland (together with some other countries) is unique in that it relies completely on coal. Other CEE countries, such as Hungary, Ukraine and Slovakia, will have an easier time to comply with commitments made. The Polish situation applies to other CEE countries at a lesser extent.

Kyoto is defective as it leaves DCs behind. CDM is not good as there are no commitments. DCs could take commitments without paying. These commitments would then be paid by third parties. This can be defined as CDM with clear targets and non-negotiable baselines.

4. Synthesis

This chapter present a topic wise summary of the 10 interviews presented in Chapter 3. It also includes a synthesis, presenting the most diverting views that came forward from the selected number of interviews. Additionally, the main conclusions from post-Kyoto workshops held before September 2001 were addressed and a selection of literature on the research topic was reviewed to fill remaining gaps. , Areas of agreement amongst the interviewees are identified, expressing the robustness of energy solutions and policy measures. The robustness of solutions and measures is further determined by their compatibility with different policy scenarios. Also, the likelihood of these solutions and measures is explored, with a special focus on whether or not they will be dependent on international measures.

Section 4.1 addresses the implementation process of the current Kyoto Protocol while Section 4.2 addresses the implementation of future post-Kyoto policies. In Section 4.3 predictions of levels of climate change and the role of international co-operation is explored. The possible technology solutions expected to be implemented under the four future climate change scenarios are synthesised in Section 4.4. Finally, Section 4.5 presents a final synthesis of the policies and instruments that could aid the implementation of these technology solutions.

4.1 Current Kyoto Protocol implementation

4.1.1 Introduction

The development of the implementation process of the current Kyoto Protocol (KP) is seen as a crucial factor on how Post-Kyoto policy implementation will be approached.

In general, the interviewees expressed various degrees of optimism towards the future of the KP. The prevalent view amongst some of the interviewed experts is that progress will be made at the coming negotiations, but that the speed at which agreements will be made will depend on the positioning of the US in these future negotiations. Repeated arguments state that climate measures will have little economic and environmental value without inclusion of the world's largest greenhouse gas emitter in any international agreements. There is added scepticism regarding US involvement in the climate regime, given their industry's perceived strong position on competitiveness, and the recent positioning of the White House on this matter. However, recent developments in the US congress, by both Republicans and Democrats, give cause for some optimism, and it is not seen as an impossible task to bring the US back to the centre of the negotiations.

A number of the experts expect the ratification of the KP by several key parties to take place shortly, but that entry into force from 2002 cannot be expected. These experts believe that ratification of the KP will take place immediately and that entry into force can be expected in 2002/2003 without US participation.

One of the main reasons for the expected progress of the implementation of the KP expressed is the political momentum as a result from the previous COPs. The Bonn agree-

ment is thought to provide enough substance for the implementation process to continue, with entry into force, and steps towards a post-Kyoto framework to be taken. It is argued that this political momentum is reflected both in domestic programs within several (mainly European) countries and in the development of initiatives within supra- and multinational financing institutions.

The positioning of the US is seen as a key factor for determining the future of post-Kyoto policies, and especially so for determining the course of action taken by developing nations. No or little involvement is expected from this group of nations without at least some level of US participation. The future of US polices is seen as very uncertain, although Minett believes that 'the Americans will come on board eventually'. In the opinion of Pachauri US participation will require a shift in the position of civil society, and then especially within the US and Canada. In the view of Baumert it is essential that the US stay out of the KP for the first commitment period, to ensure successful ratification of the protocol. The future prospects of the US climate policies are explored further by Agrawala and Andresen (2001) where the most significant development of US climate policies is stated to be 'the close relationship that Bush himself, his cabinet and close advisers have with fossil interests'. It should be noted that both the article by Agrawala and Andresen and the majority of the interviews were held prior to September 11 and do not reflect the impact of the latest events on international co-operation.

The EU has played a vital role in the previous COPs and it is expected that the EU will strive to uphold this leadership role in the future. Verbruggen, pointing specifically to the EU burden sharing being perceived as a pre-ET system, raised concerns about the role of the EU, and their positioning in the CC negotiations. The current and future role of the EU in the CC negotiations has been investigated further by Gupta and Grubb *eds* (2000).

Views differ on the positioning of Japan in the future negotiations, with some interviewees citing US/Japan ratification as a precondition for EU ratification. Nevertheless, Kimura states that the compliance issues will most likely be resolved at COP7 and that Japanese ratification can be expected shortly. He also believes that Russia will take the lead in the ratification process, depending on how favourable they view the results from the coming negotiations. He acknowledges that there is still some internal confusion within the Russian government as to how climate change issues should be approached. A further investigation into Russian climate policies was undertaken by Moe and Tangen (2001), where it was concluded, amongst other, that the current institutional and political barriers for investment in Russia may prevent the full potential benefits for the country to be reached under the existing KP.

4.1.2 Synthesis

The interviewed experts' views on the implementation of the current KP vary greatly. On the one extreme, ratification of the KP is not expected in the near future, leaving all climate-related measures to be undertaken on a voluntary and intentional basis. Nevertheless, these intentional agreements are not expected to lack substance and it is predicted that bilateral projects and domestic policy measures will play an important role in the lowering of greenhouse gas emissions.

On the other extreme, most of the experts interviewed expect ratification and entry into force of the KP within a few years, the end of 2002 often cited as a probable time for the final signing of the protocol. Although views vary over what country, or groups of countries, that will take the lead in the ratification process, most experts state that the political momentum from the previous COPs, and domestic targets for greenhouse gas emission reductions, are the most important driving factors for the implementation process of the KP.

4.1.3 Robustness, likelihood and dependency on international measures

Ratification and entry into force of the current KP is seen as both a robust and likely option. It is seen as likely that the key parties ratify the protocol before the end of 2002 and that the next step follows. The implementation of the protocol is also seen as robust. The nature of the KP makes it highly dependent, if not solely dependent, on international cooperation and international measures.

Domestic policy measures and bilateral projects are seen as likely policy options for the implementation of the current KP. Initiatives from supra- and multinational financing institutions are acknowledged, and are seen as likely measures for aiding the implementation of the KP.

4.2 Post Kyoto Protocol implementation

4.2.1 Introduction

It has been hard to identify a prevailing view on how the implementation of the post-Kyoto policies will materialise if there is a non-entry into force of the KP. In the case of non-entry it is expected that post-Kyoto policies will include more domestic programs following up on efforts already made in several European countries, bilateral projects driven by political will and domestic economic incentives such as tax and trade agreements. The interviewees expect these initiatives will result from the ratification of the KP by key parties, but, as the conservative experts do not expect the KP to enter into force in the foreseeable future, the KP is expected to merely take the form of an intentional agreement. Still, they think these intentions will be upheld and the framework as developed in the KP will be used for domestic and bilateral programs on greenhouse gas emission reduction.

Pachauri, who expects entry into force of the KP from 2002, admits that the details surrounding the second commitment period will be difficult to predict. He states that the position of civil society in the US will be a key factor for determining US involvement, and resulting developing countries (DC) participation. Baumert also sees US re-entry into the climate negotiations as essential for the second commitment period. Hare expects the negotiations on the second commitment period, US re-entry and possible DC entry, plus some additional obligations under the KP, to take place sometime after 2004. Minett also shares this view but is sceptical about the US approach to the situation, which he describes as ‘too arrogant and almost colonial in its nature’.

The following commitment periods are seen by everyone to include some sort of commitments by DCs, although these commitments are expected to take a different nature than commitments for developed countries, whose commitments are also expected to change nature.

The DC commitments for the second and coming commitment periods are expected to take a different nature than commitments for developed countries, whose commitments are also expected to change nature. Several options for DC commitments are suggested, including binding targets with non-negotiable baselines without financial commitments, commitments on 'more carbon efficient development or de-linking carbon from economic growth', sectoral commitments, and GNP based targets. Thus, it is difficult to establish any likely scenarios for DC participation and commitments for the second and later commitment periods.

A differentiation of DCs is also expected for the post Kyoto polices. Non-Annex I parties are likely to be split into two groups, although there is no agreement on how this differentiation should be done. A differentiation is not expected to take place on solely per capita or GNP comparisons, but GNP per capita is mentioned as one of the parameters that will be used to set an important threshold for commitments to be undertaken. The new group of DCs is expected to include progressive and forward thinking countries who recognise the problems associated with climate change, but who do not want to adopt Annex I like commitments. Some Latin American and Southeast Asian countries are expected to join this group, but both China and India are seen to be reluctant to accept any commitments.

4.2.2 Synthesis

The views on the post KP implementation process vary accordingly with the views towards implementation of the current KP. The experts who do not expect entry into force of the current KP do not expect any further international agreements to follow. Instead they expect domestic programs following up on efforts already made in several European countries, bilateral projects driven by political will and domestic economic incentives such as tax and trade agreements. The framework as developed in the KP will be used for these domestic and bilateral programs on greenhouse gas emission reduction.

On the other extreme, given ratification and entry into force of the KP new negotiations on the second and coming commitment periods are likely to take place shortly. Sometime after 2004 is mentioned as a reasonable time for these negotiations to take place. The main issue of these negotiations are seen to include DC participation in the climate regime and deepening of the targets for Annex I countries. The US positioning towards the KP and the coming commitment periods is seen as the most important factor for the determination of DC participation. No DC participation is expected without US participation. The issue of US participation is uncertain but most experts agree that the US will have to come aboard at some point.

4.2.3 Robustness, likelihood and dependency on international measures

No prevalent view or robust scenario has been established for the implementation of the current KP and future climate protocols. Negotiations on the second and later commit-

ment periods are expected to take place within a few years of ratification of the current KP, given such ratification. Important issues for any second or later commitment periods will be DC participation and new targets for the developed nations. DC participation is seen to be dependent on US positioning and international measures, and will also likely result in a differentiation between DCs and their commitments. A broadening and deepening of emission targets for the developed world is seen as both a robust and likely future scenario.

All interviewed experts see that the commitments for the developed world, be they legally binding or intentional, will be changed at any negotiations for the second and later commitment periods. A broadening and deepening of the emission reduction targets is seen as both a robust and likely scenario, although dependent on the ratification and entry into force of the current KP.

4.3 Predicted climate change scenarios and the role of international co-operation

4.3.1 Introduction

The level of climate change and the likelihood if international co-operation is seen to be the most important criteria for determination of future scenarios by all interviewed experts. Further criteria, suggested by Junfeng, include the efficiency of promotion of the KP and its transparency, although these criteria can also be seen as prerequisites for international co-operation. Grubb also suggests that the positioning of the US towards international environmental agreements as an important sub-criteria to determine the level of international co-operation.

The level of international co-operation is expected by all interviewed experts to dependent the actual and reported levels of climate change, although there is some disagreement as to what level of climate change is expected. Some experts point out that the effects of climate change will not be seen in the short term and that we will have to await further research before any conclusions are drawn upon this matter. However, none of these experts expect high levels of climate change in the foreseeable future and international co-operation is expected to result from political will and possibilities for trade and technology transfer between certain countries.

Pachauri expects a high level of climate change in the future, which will come about from the lack of actions taken now. He also points to the findings in the Third Assessment Report from IPCC[1]. In his view international co-operation will still be low in the near future, as it takes society 3-4 years to absorb the findings from the assessment reports, and that international co-operation will only speed up in 2015. Both Baumert and Grubb are uncertain about the levels of climate change in the future, although they both tend to expect lower levels of climate change, Baumert points to the lack of 'an ozone hole for climate change', resulting in lower perceived levels of climate change. Grubb

[1] For detailed descriptions of the assessment reports see IPPC-I (2001), IPPC-II (2001) and IPPC-III (2001).

believes that 'a reasonable prospect will be doubling of concentrations with a peak in 10-20 years'.

The other experts are somewhat divided on the issue of future levels of climate change. Minett states that to establish political will single events are more important than long-term trends. He argues that consensus on the scientific understanding of the climate change problem triggers higher levels of international co-operation. Hare expects high levels of climate change, which would result in increased international co-operation. He also holds the view that there is enough evidence at hand to prove the current and future high levels of climate change, and that waiting for long-term evidence before taking action will undermine work already being undertaken in addition to having significant impacts on the environment. Hare expects that arguments from industry in such a scenario would be that it is too late to do anything significant about the problem and that efforts should be shifted towards adaptation and a gradual transition towards a 550-560 ppmv concentration. This attitude would of course be expected to change in the aftermath of any direct climate catastrophes in rich countries.

Moorcroft suggests that levels of CC must be de-linked from strictly involving weather events in the view of the general public. If levels of CC are only associated with the weather then a few years of good weather will result in lowered interest from the public towards CC, even though the problems associated with CC might not have diminished.

4.3.2 Synthesis

There is clear disagreement towards the expected levels of climate change and international co-operation. All experts agree that these criteria are the most important for the determination of future scenarios and the only other criteria that are mentioned are US positioning and the transparency of international co-operation.

A clear split is seen on the level of international co-operation, with half of the interviewed experts expecting low co-operation and the other expecting high international co-operation. All interviewed experts expect the level of international co-operation to be dependent on the actual and reported levels of climate change. However, the linkages between the two criteria are seen as somewhat unclear.

It is seen by many experts that we will experience low levels of perceived climate change in the near future, pointing to the difficulties of communicating scientific results to the general public. The long-term characteristics of climate change and the need for further research, and consensus on this research, are also pointed to as reasons for expected low levels of perceived climate change. On the other extreme some experts argue that we are already experiencing high levels of climate change and that the future levels of climate change will be even higher as a result of low international co-operation now. This is also in agreement with Ferguson in Bruggink and Nieuwenhout (1993) who states that taking half measures may lead to 'unacceptable committed warming' and to both the 'loss of effort spent and the loss of the goal: the worst of both worlds'.

4.3.3 Robustness, likelihood and dependency on international measures

There is very little agreement amongst the interviewees regarding the future scenarios for international co-operation and no robust options or future scenarios have been identified for this. It is seen as likely that international co-operation will depend on the perceived levels of CC, although the linkages between the two are somewhat unclear.

It is also seen as likely that the levels of CC in the near future will be perceived as low. This does not necessarily reflect on the actual future levels of CC, but rather the need for continued research and communication of the research results to the general public. The levels of CC in the more distant future are seen to be strongly dependent on international measures for GHG emission reduction measures taken now. It is seen as very likely that insufficient measures now will result in increased levels of CC later.

4.4 Technologies

4.4.1 Introduction

Some of the interviewees stated that the choice of technology options for greenhouse gas reduction depends on the general trend of domestic programs and bilateral projects, based on political will and intentional agreements. Other experts were much more vocal and specific in their choices and suggestions for future technologies.

Nuclear

A number of the interviewees see nuclear energy as a technology that will remain for at least until the middle of the century. Reasons cited for this include the non-carbon nature of the technology, and maybe more importantly, the dependence of key nations on the technology. Kimura states that Japan is expected to increase its share of nuclear energy to 90% in the future. However, there is a prevalent view that nuclear represents an interim solution and that its replacement is dependent on the intensity, and success, of R&D on innovative technologies and energy solutions. Nuclear energy is believed to be an integral part of the world's energy supply until the middle of the century.

Pachauri sees that the use of nuclear energy might receive a boost in some parts of the world, US and Japan in particular, but that it will not be a favoured option in Europe. He does not expect nuclear energy to take up a large part in the future world energy market. Baumert and Grubb are also sceptical towards the future of nuclear energy, mentioning both the low cost-effectiveness and low public support as major obstacles for further use of the technology. Verbruggen suggests that nuclear might re-emerge as an energy solution in the future if R&D on the technology yield results in the coming years.

Other experts believe that nuclear energy, as an instrument to combat climate change, is a dead issue, although some countries, such as Japan, will push for increased use of the technology. However, public opinion is opposing to further nuclear plants to be built. Nuclear energy will also be excluded from JI and CDM projects. There might be discussions on the use of nuclear in several countries, UK, Sweden, and Germany were mentioned, and although there is strong opposition to the use of nuclear energy, the existing installations will not be replaced in the immediate future. Minett states that the use of

nuclear energy will be limited both from a cost effectiveness view point, with the technology having large hidden costs disguised as subsidies, and from an understanding that the technology is not 'emotionally wanted'. He also warns about the introduction of nuclear energy in DCs, as this will bring about a whole new array of problems to be dealt with.

The share of nuclear energy in future global energy supply is studied in detail by Nakicenovic, Grübler and McDonald (1998) where the share of nuclear energy is estimated to range between about 4% to 14% by 2050, depending on how future energy markets develop and how specific nuclear technologies are deployed.

Energy efficient technologies

The introduction of more energy efficient technologies is seen as a no-regret option. Prof. Zylicz especially mentions better thermal insulation of houses in Central- and Eastern Europe (CEE), as an important tool in achieving greenhouse gas emission reductions in that region. The same expert also mentions bilateral (pseudo-JI) projects involving conversion of existing coal fired low stack burners with gas fired burners with higher stacks as technology options that are certain to be explored in the future.

The experts interviewed also forecast more efficient use of energy in the future, and then especially within the transport sector. Pachauri also states that there is an abundance of no regret options if only they are assigned their true, and most often local, benefits. Baumert states that energy efficiency measures and restructuring of the power sector are measures that can be undertaken regardless of climate change agreements as these options have several incentives.

Minett states that it would be possible to improve energy efficiency by 20-40%, that cogeneration can account for up to 20-30% of all energy usage, and that renewables can account for 20%. He believes that these options can cut 20% of 65% (or 13% in total) of the total emissions, without cost effectiveness being compromised. He notes that the timetable for implementation of these measures is more important than their respective costs. In his opinion the level of taxation or other economic instruments will trigger implementation of climate change related measures, even when they are set at a relatively low level. He especially mentions the implementation of Combined Heat and Power (CHP), or cogeneration, as examples of this.

Renewable energy

There is agreement amongst the interviewees on an expected increase in the share of renewable energy (wind, biomass, solar and hydropower mentioned) in the coming years. This is expected for many reasons: domestic targets on renewable energy already agreed upon in several countries; the potential role of renewable energy together with energy efficiency technologies in technology transfer; and the added benefits of renewable energy solutions aiding other environmental and non-environmental programs, with poverty alleviation in rural developing areas cited as one important additional benefit.

One energy solution mentioned by a number of the interviewed experts is biomass energy. The experts recognise the current technical limitations of biomass fuel technology, but expect that these will be overcome through research and development. Biomass en-

ergy is seen as an underused option that will be given more focus in the future. Photovoltaic (PV) technologies are also seen to play an increasingly important role, especially given the latest developments on organic PV cells, by the progressive experts. Large-scale wind energy installations are also expected to play an increasingly important role, including both on- and offshore installations.

Pachauri is doubtful towards the role that renewable energy sources will have in the future. He anticipates an increase in the use of technologies such as fuel cells, PVs, and more efficient biomass systems, but expects that they will take up a niche market. This view is countered by several other experts who expect increased use of renewables, and then especially biomass. Baumert stresses the need for increased subsidies for renewable energy systems if these energy solutions are to play a more important role in the future.

The progressive experts identify a number of renewable energy solutions suitable for a future with high levels of climate change. Minett points to the two paths for greenhouse gas reductions identified in the Cool Europe project: a biomass dominated energy supply, and a wind and solar-based energy supply. He also points to the need for an energy carrier in the latter of these paths. Hydrogen is suggested as an option, but there are several constraints on this technology including societal, technical, and significant financial transformation costs. The COOL project gives several pathways for reaching given carbon concentrations for the Netherlands (Hisschemöller *ed* 2001), Europe (Andersson, Tuinstra and Mol *eds* 2001) and for the global community (Berk, van Minnen, Metz and Moomaw 2001).

Common for all the renewable energy solutions mentioned by the interviewees is that it is difficult to predict the final scale of the technologies, and the share they will all be assigned in the future energy system is dependent on their respective actual and perceived success and promotion.

Biological sinks

The inclusion of sinks in the KP is seen by many experts as being a weakness of the protocol. The carbon uptake levels of forestry and vegetation are disputed and the effectiveness of the mechanism is questioned. All experts, however, expect that biological sinks will be used in the future, although there is disagreement as to what levels of usage that can be expected. According to Moorcroft there is a need to learn-by-doing in connection with biological sinks. He also states that there are clear natural constraints on the use of these sinks that must be taken into account.

The use of biological sinks is seen by many of the interviewed experts to be beneficial if it is integrated with forest conservation, reforestation and biodiversity measures.

Geological sinks

Carbon extraction and storage technologies are subject to substantial research, especially in the US, and their use is seen by a few experts to hold some potential for future importance. Other experts do not share this view, with Minett labelling carbon stripping and disposal as ‘just a technical quick fix’. On a somehow similar note Hare sees carbon storage as being increasingly controversial and expects further development of this tech-

nology to meet with strong opposition from Greenpeace and other NGOs. Geological disposal in oceans and in soil is seen as 'more OK'.

Moorcroft states that the use of geological sinks will have to be undertaken in connection with already established infrastructures in the oil and gas sector, with reinjection in old, or otherwise suitable, reservoirs.

Innovation

The interviewed experts, with the exception of Pachauri and Grubb, expect massive innovations on energy solutions within the next 50 years, but find it hard to predict which way the energy systems will develop. R&D is identified as a second no-regret option, with focus on development of innovative technologies that will allow for decarbonisation of the energy system. A number of the interviewees believe in innovative technologies emerging, but believe that many of them are already present. Fuel cell technologies already being introduced at household levels in Germany are cited as a good first step in the introduction of this technology.

A hydrogen society is also seen by many as a most definite option, although it is admitted that there are several routes possible for reaching the potential of hydrogen, the most important question is seen to be what route will be chosen. According to Hare the big discussion in the future will be the choice of the new energy carrier, and then especially what type of energy will be utilised for transport purposes, and what type of transport that should be developed in the future. On the other hand, Minett finds it difficult to see a zero fossil economy emerging within the next 50-100 years.

4.4.2 Synthesis

The extreme views hold, on the one hand, that nuclear energy will play an important role in the future, with building of new nuclear power plants and credits for these under JI and CDM projects, and that renewable energy sources will only take up a niche market. On the other extreme, a biomass or wind and solar-based energy supply system is expected to emerge as the solution for future energy supply.

Nuclear

The interviewees are clearly split over some of the issues concerning nuclear energy. Some experts expect that the share of nuclear energy will rise in the future, due to individual nations' strong dependency on the technology for the security of their energy supplies. These same experts suggest R&D on nuclear energy, and possible future innovations within the nuclear technology sector, to provide the boost for its future use.

The other view holds that nuclear energy is not a cost-effective energy solution at all, with large costs hidden as subsidies. More importantly, the public trust in the technology is seen as being too low to justify any future nuclear energy installations. Nuclear energy is also not seen as a suitable option for DCs, with both the costs and the infrastructure requirements of the technology deemed as unsuitable for this group of countries.

Energy efficient technologies

The interviewees all agreed that energy efficiency would be pursued further in the future, and there was very little disagreement on the level of use of these technologies. In that respect it has been hard to establish a spread of the views on energy efficiency and more energy efficient technologies.

Energy efficiency measures are expected to be used as they have a clear added benefit in the lowering of resource use and an improvement in the cost-effectiveness of technologies and processes. Also, the inclusion of energy efficiency measures in technology transfer is seen to hold great potential for increased use of these measures.

A restructuring of the power generation sector, with a decentralised power supply system, is often mentioned in combination with energy efficiency measures. Combined Heat and Power (CHP), or cogeneration, is an often-cited option for more energy efficient power supply. All interviewees also expect more energy efficient measures within the transport sector, although again to various degrees.

Renewable energy

All interviewed experts agree that there will be an increase in the use of renewable energy sources in the future. The spread in the views of the interviewees is over the extent of usage and importance in the future energy supply these technologies will be given. The one extreme view holds that renewable energy systems will only constitute a niche market, with continued focus on further developing the energy supply systems that are present today. At the other end, an energy system dominated by renewable energy solutions; a biomass dominated supply (35% of total supply) or a wind and solar energy based supply.

Biomass energy is a technology option that is mentioned by all experts. The technical limitations of biomass fuel technology are recognised, but these are expected by many of the interviewees to be overcome through research and development. Large-scale wind energy installations, both onshore and offshore, and PV technologies are also expected to play an increasingly important role, especially given the latest developments of the technologies.

A hydrogen society is also often cited as a potential energy solution for the future. There is some scepticism towards the technology in light of its current technical limitations, but the use of small-scale fuel cells, especially within the transport sector, is seen to hold potential for future use.

Biological sinks

Some interviewed experts think biological sinks are to play an important role in the future, although they are expected to generate limited credits. These interviewees also think the importance might increase as a result of the linkages between climate change, forestry, biodiversity and other environmental pressures. On the other hand, some experts also see the science behind the issue of biological sinks as controversial and object to its inclusion in the KP.

Geological sinks

The interviewees expect geological sinks to be used in connection with existing oil and gas infrastructure, through re-injection into empty gas reservoirs or through injection into some other suitable reservoir. The technologies are seen as increasingly controversial and any future development and deployment of these technologies is expected to meet with strong opposition from environmental pressure groups.

Innovation

Most experts expect significant innovation on energy systems in the future, but have a difficult time predicting what this might entail. It is agreed that future innovation will focus on identifying a new energy carrier, and new forms of energy that can be utilised for transport purposes. However, a zero fossil economy is not seen as likely to emerge within the next 50-100 years.

4.4.3 Robustness, likelihood and dependency on international measures

The interviewed experts' technology forecasts identify a number of robust and likely technology solutions, many of which will not be dependent on international measures.

Nuclear

It is seen as likely that nuclear energy will remain as a technology for the immediate future, or at least until the middle of the century, as several nations are strongly dependent on the technology for their energy supply. However, it is also seen as both robust and likely that nuclear is seen as an interim solution and that no, or very few, new nuclear plants can be expected in the future. The two main reasons cited for this are the low cost effectiveness of the technology, with high costs hidden as subsidies, and, maybe most importantly, the low public support for the technology. In addition to these reasons the agreement reached in Bonn is seen to exclude any future inclusion of nuclear energy in JI and CDM projects, thereby making the building of future nuclear power plants a highly unlikely future scenario.

Energy efficient technologies

More energy efficient technologies are seen as very robust and highly likely options that will take place without the added incentives of international measures. The reason for this is that energy efficiency measures can be undertaken for non-climate related measures, such as an increase in the cost-effectiveness of the technology. Energy efficiency within the transport sector is also seen as a technological development that will take place regardless of international environmental agreements.

Research and development of more energy efficient technologies is seen by all experts to constitute a no-regret option, and thus highly likely. In addition to stimulating domestic research communities the role of energy efficient technologies in technology transfer is seen as an important reason for the undertaking of this option.

Renewable energy

The use of renewable energy is expected to grow by all experts interviewed and can thus be classified as a very robust policy option. This increase is expected for a number of reasons: domestic targets on renewable energy already agreed upon in several countries; the potential role of renewable energy together with energy efficiency technologies in technology transfer; and the added benefits of renewable energy solutions aiding other environmental and non-environmental programs. The use of renewable energy can thus be seen as likely to take place regardless of international measures but will be given an additional boost through such measures.

Biomass energy is seen as an underused energy option and it is seen as likely that it will be given more focus in the future. Large-scale wind energy plants and PV technology solutions are also to be seen as highly likely energy supply options in any future energy scenario. It is mentioned by several of the interviewees that these energy solutions must be given financial incentives in order to continue R&D and implementation of the technologies. This is in accordance with Grubb *et.al* (1992) who states that the growth of wind energy technology is strongly dependent on the scale, nature and consistency of government politics.

Several experts mention a hydrogen society as a likely future scenario, at the same time acknowledging the current technical and infrastructure limitations of the technology. Thus, the likelihood of the technology is seen to be strongly dependent on the research and development that goes into it. For the moment, the development of hydrogen technology is seen to be independent of international measures, but a price for carbon and an effective ET system are seen to give additional boost to its future use.

Biological sinks

The use of biological sinks is seen as a robust option, although there is disagreement to what level of usage the mechanism will have. This is seen to be strongly dependent on international measures, and well-defined guidelines and regulations for the credits to be achieved by such measures.

It is seen as likely that biological sinks will experience higher levels of use if the mechanism is linked with forest conversation, reforestation and biodiversity measures.

Geological sinks

There is very little agreement amongst the interviewed experts regarding the use of geological sinks and no robust or likely options were identified. There was no mention of any inclusion of these measures in international agreements and the issue was not given particular attention by any of the interviewees.

Innovation

It is seen as both robust and likely that there will be technology innovations within the energy sector within the next 50 years. These innovations will result from R&D on energy and non-energy technology solutions, and will be the result of international co-operation to the extent that R&D is co-ordinated on an international level.

The most mentioned area of innovation was the transport sector, and it can be seen as likely that the attention of R&D will focus on finding a new energy carrier for this sector. No robust or likely technology options for the transport sector has been identified, although a hydrogen society, which would involve hydrogen fuel cells for vehicles, was mentioned in connection with other questions.

4.5 Policy implementation

4.5.1 Introduction

A prevailing position amongst the interviewees is that energy efficiency measures and research and development on innovative technologies are to be seen as the no-regret policies that will be undertaken regardless of any future scenario. Technology transfer, especially of energy efficiency technologies, is seen as increasingly important for developing nations in their combat to reduce greenhouse gas emissions. Here, technology transfer is given a broad definition, including a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to CC (Metz *et.al* 2000). All three Kyoto Mechanisms (KMs) are seen as important instruments, which will certainly be used to various degrees, depending on the level of international co-operation. Prof. Zylicz again points out that most international projects will be bilateral in the beginning, driven more by the political momentum and political will in European countries than any economical or environmental considerations.

The understanding that energy efficiency measures, R&D, and technology transfer are to be considered as no-regret options is not shared by Hare. He states that he does not believe in the concept of no-regret options. Although he admits that energy efficiency and R&D can be seen as such, he points to the lack of action on these policies in the past. If these options really were seen as no-regret options they would have been implemented to a much higher degree already. In his view no-regret policies have been identified but politicians too often cut back on funding, and the implementation of these options is often met with opposition when initiated.

Prof. Zylicz identifies pseudo-JI projects driven by political will, taxes and trade incentives as emerging instruments within Europe. These projects are expected to include both energy efficiency measures and process related measures, such as conversion of existing coal fired low stack burners with gas fired burners with higher stacks. These projects will not be economically driven, in fact they are not expected to be cost effective, but if international co-operation can result in increased benefits, in reality: a higher price for carbon, then these projects are expected to flourish and their impacts to significantly increase.

Pachauri does not believe that the KMs will play a major role in the near future and he is sceptical to the scale at which these mechanisms will be implemented. He does not expect larger reductions than 1-1.5% (from 1990 levels) within the first commitment period. In his view a key issue will be to see how the money-flow from the North to the South will develop, especially in the light of the new funds that are being introduced. The Global Environment Facility (GEF) is mentioned in particular. See also Gupta (1995 and 1997) for a further investigation of the financial mechanisms for the imple-

mentation of the FCCC, and the North-South aspects of the GEF. Other policy instruments mentioned by Pachauri include pricing and taxation of energy at a European level and instruments that are explored by several researchers. Sachs, Loske and Linz *et al.* (1998) not only points out the importance of introducing such instruments for control of the environment but also identify the need to reduce ecologically damaging subsidies and tax provisions.

Baumert and Grubb are also sceptical about the role of the KMs but expect that emission trading will play an important role for the first and coming commitment periods. According to Baumert the momentum for ET has been building for years and is seen as more interesting for both business and government than taxation. These efforts will also all be linked to energy efficiency and energy sector reform.

A variety of policy instruments will be used to meet the obligations under the current KP and post-Kyoto agreements. ET on European level and EU programs on enhancement of renewable energies, including energy efficiency standards and domestic programs on renewable energy, are all options that are expected in the near future. Energy taxation at EU level is also an option that will possibly emerge, and changes at the transport level within EU should be expected.

Minett states that it will be important to introduce proper standards on energy use, as already seen in the energy sector. He also suggests a phasing out of power generation where energy standards, such as already seen on appliances and cars, could also be transferred to power stations. The standards could be put as carbon efficiency, age, or efficiency. By tightening the targets over time there would be a gradual phasing out of the most polluting stations and processes. This will open space for renewables and cogeneration. This measure should also be introduced for cars and appliances on a larger European scale. The expert notes that the Commission is willing to go down this and other routes, but that Member States (MS) are more sceptical. He believes that increased levels of climate change will result in increased MS participation, and we might have a shift from the traditional north-south EU divide into an east-west divide. Then again, he notes, 'the CEE countries might surprise us

Other policy instruments recommended by Minett include specific targets for EU member states, either carbon or efficiency targets, which should be set through environmental policies as energy policies will not allow for these changes under the Treaty. He sees that these targets will have to be set in a way such that governments will have to meet at least two targets within their term of office. In this way he believes we will avoid responsibility being placed on previous administrations, the reluctance to pass legislation by governments, and other person problems. He states that 'governments are not good at long term planning' and suggests that the way to avoid this problem is to use international treaties. The targets could also be set under these treaties, although not for the first commitment period of the KP. Targets should be annual or biannual, ensuring that two milestones are met per parliament/term of office.

As for immediate action in countries outside the EU, Hare expects that New Zealand will deal with their need to improve the energy efficiency of their economy and that no further fossil options will be explored there. He expects no significant action from either

Australia or Canada, whereas Japan is expected to actively use the KMs and introduce top-down rules for energy efficiency.

Climate change related policies and instruments are seen by all experts to have both double and triple benefits. Junfeng especially mentions poverty alleviation in rural areas resulting from wind and solar energy projects. Pachauri sees that the link between climate change related measures, added benefits, and other international agreements is still unclear. He believes that more co-ordination is important to properly link these agreements. A focused and efficient use of resources for implementation is seen as necessary. He also identifies areas of overlap, including the Montreal Protocol, Certification, Biodiversity, and Forestry, and stresses the need for a system to co-ordinate these overlaps. The issue of synergy between the Montreal and Kyoto Protocols and efforts to enhancing synergy between environmental agreements, including the Environmental Management Group recommended by the UN and scheduled to start in 2001, is described in detail by Oberthür (2001).

Baumert agrees that there are definite double benefits and linkages, such as in land use change and forestry. He states that these benefits will assist not only in tropical areas but also in areas of desertification. In his view there is certainly potential for climate protection offsets to be used for biological diversity measures leveraged to make ecosystems healthier. 'There is a need for environmental criteria in the KP that go beyond simply climate change related measures'.

On another note, Hare believes that without any economic incentives resulting from international co-operation present, the benefits are not seen as significant to justify projects. However, given the right economic incentives, projects that will address greenhouse gas reductions, water management, biodiversity and deforestation, are all expected to play an increasingly important role, not only in climate change policies, but all environmental problem areas.

All interviewed experts agree that there will be continuation of some already agreed domestic and international programs and technology solutions regardless of international co-operation. This progress will come about for different reasons, political drive once again cited as an important factor. In the view of Hare, however, most countries will not go ahead with their programs in the absence of international action. In his understanding the UK, Sweden, Germany and maybe also the Netherlands are countries that are seen as progressive enough to continue their work regardless of international agreements. No actions are seen as guaranteed at EU level. In the absence of an international agreement Hare believes that the leaders, Germany mentioned, will probably lose their interest in climate change policy development and their leadership position might collapse.

No dominant position on the issue of policy options versus economic growth has been established. Some of the interviewees claim that there exists a point of optimal abatement, but none are able to tell exactly where this point will be and how it should be identified. Again, this reflects on the issue of economic incentives being provided through international agreements, as the conservatives do not see most policy options as cost effective at this moment, of course with the exception of the no-regret policies as identified by these experts.

Pachauri believes that the implementation of climate change related measures will have no significant impact on economic growth, stating that local, and global, benefits need to be adequately quantified. This view is shared by Baumert who states that climate change related policy measures need to be perceived as good for the economy and that low cost measures must be pursued. Grubb does not believe that climate change measures will have any negative impact on economical growth whatsoever. In his opinion the cost of these measures will amount to 0.1-0.2% of GNP, maybe higher for some countries. This will be outweighed by more strategic innovation and less use of resources. Verbruggen points out that there will be winners and losers but that overall impact on the economy will be zero as the two will outweigh each other. Moorcroft points to the inadequacy of our current economic models to deal with these questions, suggesting that analysis with beneficial growth models will show positive impacts on the economy.

This view is shared by Minett who states that a move towards more sustainable technologies will stimulate technological development and create a whole new market that will contribute to the economy. He states that cogeneration, renewables, and energy efficiency are all beneficial for the economy, whereas end-of-pipe solutions are merely costs. On the other hand, Minett believes that there might be an effect on the economy as the reduction commitments are increased, but that new economies might emerge that will offset any negative impacts. Hare points out that it will be easier to renew infrastructure with a high level of economic growth as there will be larger replacement of capital, and the system might be self-regenerating. For developing countries there might be a different dynamic. He expects that failure of energy and non-energy technology solutions to repay their investments in these countries will result in a lock-in on fossil technologies.

4.5.2 Synthesis

All experts agree that the Kyoto Mechanisms (KMs) will be used, but there is disagreement as to what level of use they will have and what importance they will play. On the one extreme no significant impact is expected from these mechanisms, whereas on the other extreme they are expected to play a significant role in meeting the commitments under the current and future climate protocols.

Other policy instruments mentioned by the interviewees include pricing and taxation of energy at a European level, and to a larger extent, energy efficiency standards or targets, and domestic programs on renewable energy. Changes at the transport level within EU should also be expected.

CC and CC related policies and instruments are seen by all experts to have both double and triple benefits. The benefits identified vary somewhat, but several experts mention the links between CC measures and forestry conservation, land use and land use change. Additional linkages mentioned include control of ozone depleting substances, issues concerning desertification, biodiversity, and poverty alleviation in rural areas in DCs. A further non-environmental benefit is identified as technological leadership, and thereby the emergence of new technologies and new economies.

Additionally, CC and CC related measures are seen to have complex impacts on trade and trade regimes. Most importantly, the understanding of the links between ET and the other two KMs on international trade are seen as insufficient and suggested as areas for

further research. The importance of a careful design of an ET system to avoid conflicts with international trade and international trade law is covered further by Grimeaud (2001). Hasselknippe, Høibye and Pautler (2002) give an overview of a number of national GHG ET schemes and their links to the other KMs.

On the issue of the impact of climate and climate related measures on the economic growth there is again a clear divide. Some of the experts state that this is a very important consideration that should always be taken into account when designing climate policies, whereas others dismiss this notion as nonsense. On the other hand, some experts state that if the local and global benefits are assigned their true value there should be no need for further added economic incentives from international measures. On a similar note, according to Shogren in Carraro *ed* (2000) benefits must be properly quantified in order to find a price that will induce DCs to come aboard the KP.

Additional benefits that should be quantified are the benefits of technological leadership, the emergence of new technologies, and more controlled use of resources. This is also reflected in Patt (1999) where it is stated that 'although economic models are of great use in guiding decision-makers on some aspects of the problem, they provide an incomplete picture of the fundamental decision of when and how much to act to avoid climate change'.

4.5.3 Robustness, likelihood and dependency on international measures

The use of the KMs is agreed by all the interviewed experts and the can be seen as robust policy option. However, the likelihood of the different mechanisms is more uncertain. The level of usage of the KMs is seen to be clearly dependent on the level of international co-operation. ET is seen as the most likely of the KMs as the political momentum for this measure is great, coupled with a clear and present interest from business and industry. The use of the other two KMs, JI and CDM is unclear, and is seen to be even more strongly linked to international measures. According to Brander (2001) the major obstacles with the KMs are: supplementarity, hot air, adaptation tax, the inclusion of sinks, crediting periods, compliance rules and liability provisions, and transaction and institutional costs.

Energy efficiency standards and domestic programs on renewables are mentioned by several of the interviewed experts and can be seen as robust and likely policy options that are expected in the near future. Pricing and taxation are not seen as very robust climate measures and their likelihood is also not seen as high. This should especially be seen in the light of the relative high likelihood of ET, with taxation being seen as less interesting, especially from a business perspective.

Several added benefits from climate and climate related measures were identified and clearly robust and likely linkages are found between CC measures and forestry conservation, land use and land use change. The emergence of new technologies, technological leadership and new economies can also be seen as robust and likely scenarios to emerge from CC measures.

Only a few experts identify a significant impact of CC measures on economic growth. The majority expects CC measures to have either a limited and justifiable negative impact, or indeed a positive impact, on economic growth and this can thus be seen as likely.

Again, this reflects on the issue of economic incentives being provided through international agreements, as further economic incentives provided through these agreements would limit the disagreement on this issue.

4.6 Pace of greenhouse gas emission reductions

4.6.1 Introduction

Given the diversity of views amongst the interviewed experts on a number of issues it is hardly surprising that their views on the pace of GHG emission reductions cover a wide area of future scenarios. In addition, the time-scales of the emission reduction forecasts are different, with some interviewees choosing not to speculate much further than the first commitment period.

Zylicz expects that by 2008-2012 the Annex I countries, including the US, will reach their Kyoto targets. The only exceptions are seen to be economies in transition, which will be somewhat below their respective targets. He does not expect non-Annex I countries to increase their emissions dramatically: perhaps 20% over the 1990 level. Moorcroft also does not wish to speculate any further than the end of the first compliance period. He expects that 60% of the KP target will be met by the end of the first compliance period, but also that 'if we focus on the game then the results will be better'. Kimura does not expect any reduction of GHG emissions from 1990 levels to be achieved, except from in the EU. He states that he does not have enough information to speculate any further.

Baumert comments that any prediction will of course depend on whether the KP enters into force or not, and many other factors. He states that he would be very impressed if industrialised countries returned to 1990 levels by 2010, giving this as his best-case scenario. Continuing with this scenario, reductions on the order of 20% by industrialised countries could be achieved by 2020. If this pace were to continue for the following 10 years reductions on the order of 40% would be achieved by 2030. Using 1990 as a benchmark, he does not expect developing countries will return to those levels until 2030 or beyond. He adds that this is 'a wild guess' and dependent upon a myriad of factors, such as technological development, technology transfer, the evolution of the multilateral trading system (not ET), democratisation, the future physical impacts of climate change, etc.

A very rough guess by Grubb estimates around 1% GHG reduction per year post 2010 for Annex I countries. It is not clear whether this assumes that 1990 levels are reached by 2010 or not. Assuming that reductions only start effectively in 2010 this would result in Annex I countries reaching their 1990 levels around 2020[2], with GHG reductions on the order of 10% by 2030 and 30% by 2050. If we assume that the KP targets are reached for the first commitment period this pace of reduction would result in about 25% GHG reductions by 2030 and 45% by 2050.

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[2] This estimate is based on UNEP data on emissions of GHG in Annex I countries and globally produced for COP6. The data can be accessed at: http://www.grida.no/climate/.

Verbruggen estimates that reductions in the magnitude of 10% could be reached by 2010, but only if the KP mechanisms are working well and the instruments are credible. He would then expect a doubling every 10 years, resulting in reductions of 30% by 2030 and 50% by 2050.

The COOL project investigates the possibilities for reducing GHG emissions by 80% by 2050. According to Minett this reduction can be reached if there is a shift of the energy system towards renewable based energy supplies.

The other experts either chose not to speculate on the pace of GHG emission reductions, or did not respond to our request. Further forecasts on the pace of reduction will be included in any later versions of this report.

4.6.2 Synthesis

Figure 1 gives a graphical representation of the various emission projections for Annex I countries suggested by the interviewed experts. The figure does not show the views of Zylicz, Moorcroft and Kimura who chose not to speculate any further than the end of the first compliance period to the KP. The curves of the emission projections have in some cases been extrapolated using the growth rates suggested by the interviewees. Grubb is represented by two curves, reflecting the different starting points of the GHG emission reductions, now or in 2010. It should also be noted that the emission forecasts by Baumert and Minett follow the same reduction pattern for the period 2020 to 2050.

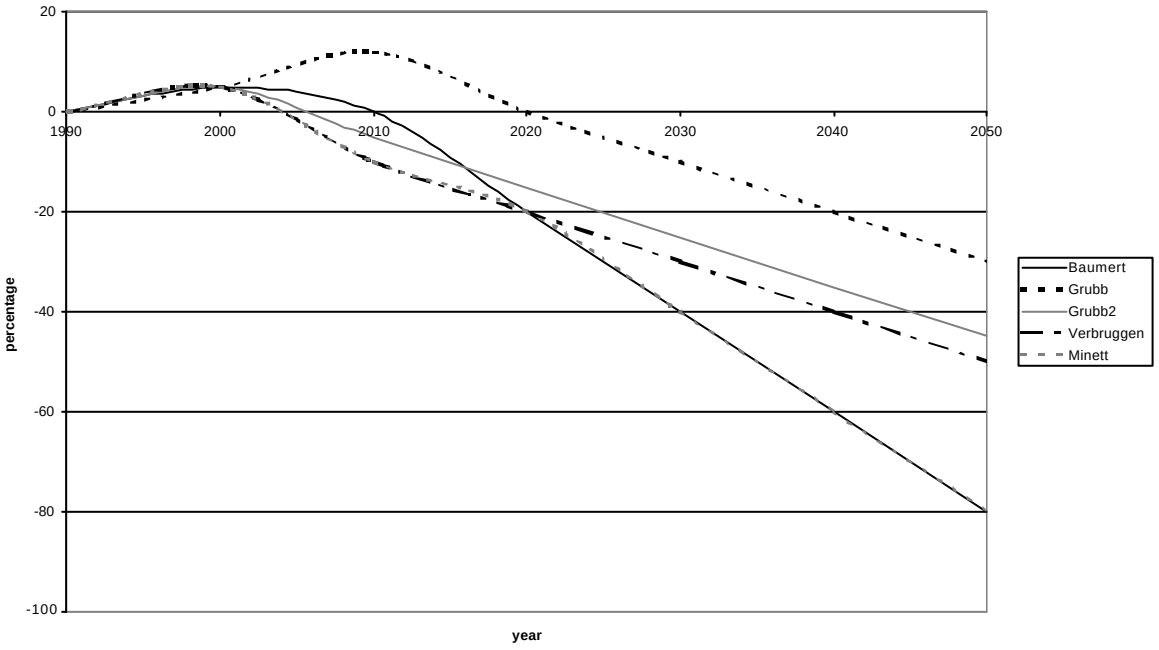

Figure 1 Emission projections for Annex I countries, 1990 to 2050. In percentages.

The two extremes for the future GHG emission reduction are clearly presented in Figure 1. The range of reduction is between 10% and 40% by 2030 and 30% and 80% by 2050.

These emission forecasts are not easily translated into concentration levels. A full analysis would require the use of atmospheric modelling and would be outside the scope of this report. However, Enting (1998) gives projected concentrations for various Annex I emission reduction scenarios. A quick comparison with these projections shows that the range of concentration levels goes from 430 ppmv to 440 ppmv in 2030 and 450 ppmv to 470 ppmv in 2050. These estimates are in line with the projected concentrations calculated by Enting, where it is stated that 'going from a 1% per annum reduction to 2% per annum reduction achieves little change in the level of CO_2 in the atmosphere, if reductions are confined to Annex I nations'. The estimates are also in accordance with IPCC Technical Paper 4 (IPCC, 1997) where it is shown that a 2% reduction per year starting now, roughly corresponding to an 80% reduction by 2050, would result in a clear tendency towards a stabilised concentration from 2100.

A study by van Vuuren and de Vries (2001) from the National Institute of Public Health and the Environment (RIVM) in the Netherlands investigates two different mitigation scenarios for stabilising CO_2 concentrations at 450 ppmv by 2100, based on the B1 baseline scenario[3]. The study uses the same projections as Enting[4] and shows that a stabilisation at 450 ppmv by 2100 is technically feasible. The costs and benefits of early action versus delayed response were also studied and it was found that 'postponing measures foregoes the benefits of learning-by-doing'.

4.6.3 Robustness, likelihood and dependency on international measures

No generally agreed view on the pace of GHG emission reductions could be derived from the interviews and thus no robust or likely scenario has been identified. The emission reduction scenarios are seen to be highly dependent on international measures and co-operation. Without international agreement on the KP and its future compliance periods only limited GHG reductions are expected.

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3 See the Special Report on Emissions Scenarios (IPCC, 2000).

4 Personal communication with Mr Michel den Elzen from RIVM.

5. Summary

This report builds on interviews conducted with 10 international experts on climate change and climate change related measures and policies and a small review of results from international workshops and international literature on these issues. The focus of the research was on the question: what policy measures and instruments, including technology options, have to be taken in the short-term (e.g. 2003) to facilitate long-term (after 2010) climate policy development? The objective of the research was to present an overview of the different views on post-Kyoto climate policy implementation and not to give a blueprint of future technologies. Gaps in visions brought forward were filled to the extent possible based on available literature and results from workshops on post-Kyoto issues. The results of the research were analysed to determine whether policy options are robust (i.e. that they are compatible with different socio-economic development scenarios) or if they are likely to be autonomous. The possible relationship with the domestic measures and international co-operation were also identified.

The majority of the interviewed experts expect ratification and entry into force of the KP within a few years. It is agreed that the political momentum from the previous COPs, and domestic targets for greenhouse gas emission reductions, are the most important driving factors for the implementation process of the KP. The implementation of the KP is expected regardless of the US positioning towards the process. Nevertheless, the positioning is seen as important for the development of the climate change regime (e.g. the development and functioning of the FCCC process and developing country participation in the KP).

If there is no entry into force of the current KP then no further international agreements are expected to follow. Given ratification and entry into force of the current KP new negotiations on the second and/or coming commitment periods are likely to take place shortly (after 2004). The main issues of these negotiations are seen to include Developing Country (DC) participation in the climate regime and deepening of the targets for Annex I countries. The targets for DCs are expected to take on a different nature than current KP targets for Annex I countries, and a differentiation of the DCs is also expected.

It is seen as likely that the levels of climate change will be perceived as low in the near future, resulting from the difficulties of communicating scientific results to the general public. This does not reflect on actual levels of climate change, which are expected to increase significantly in the absence of international measures taken now. The level of international co-operation is seen to be dependent on the actual and reported levels of climate change and on public perception.

The technology forecasts identify a number of robust and likely technology solutions, many of which will not be dependent on international measures. More energy efficient technologies for households, industry and transport are seen as very robust options and highly likely to take place without the added incentives of domestic measures and/or international so-operation. The role of especially industrial and transport energy efficient technologies in technology transfer is seen as an important reason for the undertaking of

these options. All experts agree that there will be an increase in the use of renewable energy sources in the future. Biomass energy is seen as an underused and likely option that will be given more focus in the future. Photovoltaic technologies and large-scale wind energy installations are both seen to play an increasingly important role, especially given the latest developments of the technologies, and are seen as highly likely energy supply options in any future energy scenario. A hydrogen society is often cited as a potential energy solution for the future. However, the likelihood of the technology is seen to be strongly dependent on the research and development that will go into the technology. It is seen as likely that nuclear energy will remain as an interim technology solution until the middle of the century. It is agreed that future innovation will focus on identifying a new energy carrier, and new forms of energy that can be utilised for transport purposes. Nevertheless, a zero fossil economy is not seen as likely to emerge within the next 50-100 years.

The interviewees do not see carbon extraction and disposal technologies as likely to hold any potential of future importance. They do think biological sinks will play an important role in the future, although they are expected to generate limited credits. They expect geological sinks to be used in connection with existing oil and gas infrastructure, but they do not expected them to play a prominent role in future GHG abatement programs.

The experts think the level of use of the Kyoto Mechanisms (KMs) is clearly dependent on the level of international co-operation. Emissions Trading (ET) is seen as the most likely of the KMs as the political momentum for this measure is great, coupled with a clear and present interest from business and industry. The use of the other two KMs, Joint Implementation (JI) and the Clean Development Mechanism (CDM), is unclear and they are seen to be even more strongly linked to international measures. Other policy instruments mentioned include pricing and taxation of energy at a European level.

Climate change- and climate change related policies and instruments are seen by the interviewees not only to have direct positive effects on future climate and benefits for reduction of direct impacts, but also to have many other environmental- and non-environmental benefits. These include forestry conservation, land use and land use change, biodiversity, control of ozone depleting substances, issues concerning desertification, and poverty alleviation in rural areas in DCs. An additional benefit is technological leadership, and thereby the emergence of new technologies and new economies.

Climate change- and climate change related measures are seen to have very little impact on economic growth by the interviewees. It is argued that analysis using current economic models will show some small negative impacts. New economic models looking at beneficial growth, including properly quantified costs and damages, are expected to yield positive impacts of climate change related measures on economic growth.

The pace of GHG emission reduction predicted by the interviewees ranges from 10% to 40% by 2030 and 30% to 80% by 2050. By using data from CSIRO and RIVM it is estimated that these reduction levels will correspond to CO_2 concentration levels of 430-440 ppmv in 2030 and 450-470 ppmv in 2050.

6. Samenvatting

In dit onderzoek naar internationale visies op post-Kyoto klimaatbeleidsimplementatie werden 10 internationaal gerespecteerde experts op het gebied van klimaatverandering, klimaatbeleid en klimaatverandering gerelateerde maatregelen geïnterviewd. Daarnaast werden de resultaten van een aantal internationale workshops en literatuur over deze onderwerpen gereviewd. Speciale aandacht werd besteed aan de vraag welke maatregelen en instrumenten, met inbegrip van technologische opties, op korte termijn (vanaf 2003) noodzakelijk zijn ter facilitering van lange termijn (na 2010) beleidsontwikkeling. Het onderzoek had tot doel inzicht in de extreme visies op op klimaatbeleidsimplementatie te verkrijgen en niet om een blauwdruk voor technologische opties te geven. Op basis van beschikbare literatuur en resultaten van recent gehouden post-Kyoto workshops vond aanvulling plaats op punten waar de geïnterviewden geen duidelijke visie naar voren brachten. De robuustheid van geïdentificeerde opties en maatregelen werd bekeken op basis van de compatibiliteit met verschillende socio-economische ontwikkelingsscenario's. Tot slot werd onderzocht of het waarschijnlijk is dat de opties en maatregelen zonder binnenlandse beleidsmaatregelen en/of internationale samenwerking tot stand zullen komen.

De meerderheid van de geïnterviewden verwachten dat het Kyoto Protocol (KP) binnen enkele jaren zal worden geratificeerd en van kracht zal worden. Als belangrijkste drijvende krachten achter de implementatie van het KP worden de uit de afgelopen Conferences of Parties (COPs) voortkomende politieke momentum en de binnenlandse doelstellingen voor reductie van broeikasgasemissies genoemd. Verwacht wordt dat, ongeacht de positie van de VS, de implementatie van het KP door zal gaan. De positie van de VS ten aanzien van het proces wordt echter als belangrijke factor voor de ontwikkeling van het regiem gezien. Hierbij wordt met name de ontwikkeling en het functioneren van het FCCC proces en de deelname door ontwikkelingslanden in het KP bedoeld.

De geinterviewden verwachten dat nieuwe internationale overeenkomsten niet tot stand zullen komen indien het huidige KP niet van kracht wordt. Indien het huidige KP in de komende jaren geratificeerd en van kracht wordt dan zullen de onderhandelingen voor de tweede en/of latere perioden van verplichtingen op korte termijn, waarschijnlijk na 2004, van start gaan. Als belangrijkste onderwerpen van deze onderhandelingen werden de deelname van ontwikkelingslanden in het regiem en een verdieping van de doelstellingen voor Annex I landen genoemd. Aangegeven werd dat doelstellingen voor ontwikkelingslanden in de komende perioden waarschijnlijk anders zullen zijn dan de doelstellingen voor Annex I landen in het huidige KP. Tevens wordt verwacht dat een verdere differentiatie van doelstellingen tussen verschillende groepen van ontwikkelingslanden zal plaatsvinden.

Volgens een aantal geinterviewden zal in nabije toekomst zal, door slechte communicatie van wetenschappelijke onderzoeksresultaten, het algemene publiek waarschijnlijk denken dat klimaatverandering een langzaam proces is. Verwacht wordt derhalve dat, bij afwezigheid van internationale maatregelen, klimaatverandering significant zal toenemen in de nabije toekomst. De mate van internationale samenwerking wordt sterk afhan-

kelijk geacht van de waargenomen en gerapporteerde klimaatverandering en de publieke perceptie.

Een aantal robuuste en waarschijnlijke technische oplossingen voor het terugdringen van de emissie van broeikasgassen werden geïdentificeerd waarvan een groot deel onafhankelijk van internationale samenwerking tot stand zal komen. Een toename van de inzet van energie-efficiënte technologieën in huishoudens, industrie en transport wordt gezien als zeer robuuste het is zeer waarschijnlijk dat deze opties onafhankelijk van binnenlandse beleidsmaatregelen en/of internationale samenwerking tot stand zullen komen. Een belangrijke reden hiervoor is de verwachte grote rol die energie-efficiënte technologieën, met name voor industrie en transport, zullen spelen in technologieoverdracht. Verder is er consensus over dat het gebruik van hernieuwbare energiebronnen in de nabije toekomst sterk zal toenemen. Biomassa wordt gezien als onderbenutte en waarschijnlijke optie welke in de nabije toekomst meer aandacht zal krijgen. Verder wordt verwacht dat fotovoltaische technologieën en grootschalige windenergie, vooral gezien de recente ontwikkelingen van deze technologieën, in de nabije toekomst een belangrijke rol in de energielevering zullen gaan spelen. Nucleaire energie wordt als een interim technologische oplossing gezien tot halverwege deze eeuw. Een waterstofmaatschappij wordt vaak geciteerd als potentiële energie oplossing voor de toekomst. De waarschijnlijkheid hiervan wordt echter sterk afhankelijk geacht van de onderzoeks- en ontwikkelingsactiviteiten in de nabije toekomst. Er bestaat overeenstemming over dat toekomstige innovatie zich vooral zal richten op het identificeren van nieuwe energiedragers en nieuwe vormen van energie voor transport. Desalniettemin wordt het niet waarschijnlijk geacht dat in de komende 50 tot 100 jaar een nul procent fossiele brandstofeconomie gerealiseerd zal worden.

De geinterviewden achten het wordt niet waarschijnlijk dat koolstofextractie en –verwijdering in de toekomst grote potentie zullen hebben voor het reduceren van emissies van broeikasgassen naar de atmosfeer. Zij verwachten wel dat biologische sinks een belangrijke rol spelen, hoewel verwacht wordt dat deze slechts in beperkte mate credits zullen genereren, terwijl geologische sinks waarschijnlijk benut zullen worden in samenhang met bestaande olie- en gasinfrastructuur. Zij verwachten echter niet dat geologische sinks een prominente rol in toekomstige programma's ter vermindering van broeikasgasemissies zullen innemen.

De mate van gebruik van de Kyoto Mechanismen (KMs) wordt sterk afhankelijk van de mate van internationale samenwerking gezien. Emissiehandel ('Emission Trading') wordt gezien als het meest waarschijnlijke Kyoto mechanisme omdat het politieke momentum hiervoor het grootst is en er een duidelijke interesse vanuit het bedrijfsleven en de industrie voor dit mechanisme is. Het gebruik van de twee andere mechanismen, 'Joint Implementation' en 'Clean Development Mechanism', is onduidelijk. Zij worden gezien als sterk gekoppeld aan internationale maatregelen. Andere beleidsinstrumenten die werden genoemd zijn prijsbeleid en belasting op energie op Europees niveau.

Klimaatverandering gerelateerd beleid en beleidsinstrumenten hebben, naast voordelen voor het klimaat en vermindering van mogelijke directe effecten, ook vaak vele andere voordelen. Door de geinterviewden werden voordelen voor bescherming van bossen, landgebruik en veranderingen in landgebruik, biodiversiteit, bescherming van de ozonlaag, tegengaan van verwoestijning en armoedereductie in rurale gebieden in ontwikke-

lingslanden genoemd. Een extra voordeel is technologisch leiderschap wat gepaard gaat met het opkomen van nieuwe technologieën en nieuwe economieën.

De geinterviewden verwachten dat klimaatverandering gerelateerde maatregelen weinig effect zal hebben op mondiale economische groei. Analyses met bestaande economische modellen geven aan dat kleine negatieve effecten op de mondiale economische groei op zouden kunnen treden. Nieuwe economische modellen, die op een juiste wijze de kosten van technologieën en schade aan systemen meenemen zullen echter naar verwachting positieve effecten van maatregelen op economische groei aantonen. De eerdergenoemde indirecte voordelen van maatregelen zullen de positieve effecten mogelijk vergroten.

Ten slotte verwachten de geinterviewden dat de emissies van broeikasgassen, in CO_2 equivalenten, tegen 2030 10 tot 40% lager zullen zijn dan het 1990 niveau. Tegen 2050 wordt dit verwacht op te lopen tot 30 tot 80% lager dan het 1990 niveau. Op basis van data van CSIRO en RIVM werd geschat dat deze emissiereducties zullen leiden tot CO_2 concentraties in de atmosfeer van 430 tot 440 ppmv in 2030 en 450 tot 470 ppmv in 2050.

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Appendix I. Key interview questions

The key questions that emerge from the above discussion are presented below. These questions are not to be seen as questions for a questionnaire and thus can be developed further and adapted based on and during the interviews.

a) What is the likely future of the Kyoto Protocol? How do you expect that policy will/should develop in the post-Kyoto period (e.g. after 2010) internationally and domestically? (The purpose of this question is to allow the expert to give his own view on the possible future of the climate change regime, and to give us the opportunity to include elements we had not thought of before. Thus the linkage to and importance of other conventions will also be addressed here)

b) In particular, what do you think is likely to happen? How can the implementation of the FCCC be continued and the momentum kept up even in the absence of the entry into force of the KPFCCC.

   a. All key parties ratify the Protocol and the next steps follow?

   b. The Protocol is ratified by Europe, Russia, Ukraine, key developing countries and AOSIS; and although it does not enter into force, countries take this seriously.

   c. Only AOSIS ratifies the Protocol and no one takes it seriously.

   d. Despite non-entry into force, most countries take it seriously: Implementation without ratification.

c) We have selected two criteria to determine future scenarios: the changing climate and the likelihood of international co-operation: are these two criteria sufficient in your view or would you suggest other criteria?

d) Given these criteria, what policies and instruments are likely to be undertaken in each of the four scenarios and why?

e) What will be the relative importance of energy and non-energy solutions in these scenarios? What will be the role of amongst others nuclear power and clean-fossil technologies? Are clean-fossil technologies and other idetified solutions to be seen as an interim or final solution?

f) What will be the benefits of the identified policies and instruments for other environmental goals? (For example, reducing deforestation is good for water management, combating soil erosion, dealing with loss of biodiversity etc.)

g) Which of the four scenarios do you see as likely and why?

h) Which climate change (related) policy options are likely to take place irrespective of the scenarios?

i) What climate change (related) domestic measures can be taken irrespective of agreement at EU and international level?

j) What climate change (related) domestic measures can only be taken on the basis of international agreement?

k) Which policy options can be promoted without risking national economic growth under all four scenarios?

l) What are the possible packages of commitments for the second and following commitment periods for different groups of countries?

m) What short-term policy options for promoting technological and institutional change at the national level are robust, feasible and compatible with the different scenarios of medium and long-term climate policy?

n) What pace of GHG emission reduction do you expect in the future? What percentage of reduction can be achieved by what year? How will this correspond to atmospheric concentration levels of CO_2 equivalents?

Appendix II. Interviewees

Mr Kevin Baumert
Research Fellow, World Resources Institute, USA

Prof Michael Grubb
Imperial College of Science, Technology and Medicine, UK

Mr Bill Hare
Climate Policy Director, Greenpeace International

Mr Li Junfeng
Director, Energy Research Institute, China

Mr Kotaro Kimura
Director, Global Industrial and Social Progress Research Institute, Japan

Dr Simon Minett
Cogen Europe

Mr Dave Moorcroft
World Business Council for Sustainable Development
British Petroleum

Dr RK Pachauri
Director, Tata Energy Research Institute, India
Vice Chair, IPCC

Prof.dr. Harmen Verbruggen
Director, Institute for Environmental Studies (IVM), The Netherlands

Prof.dr.hab Thomas Zylicz
Warsaw University, Department of Economics